Errata

Title & Document Type: **4271B Digital LCR Meter Operating and Service Manual**

Manual Part Number: **04271-90003**

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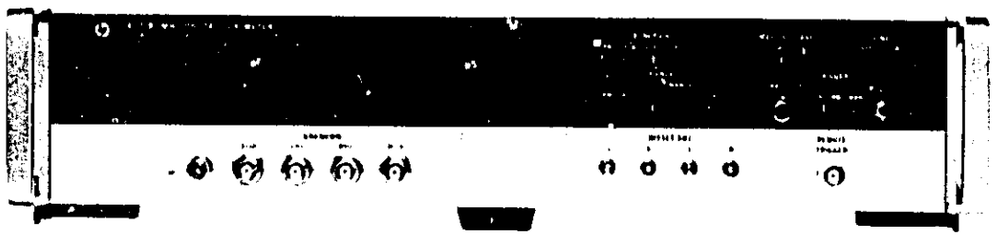
OPERATING AND SERVICE MANUAL

4271B
1MHz DIGITAL LCR METER



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OPERATING AND SERVICE MANUAL

MODEL 4271B
1 MHz DIGITAL LCR METER
(including Options 001, 002, 003, 004 and 101)

This manual applies directly to instruments with serial numbers prefixed 1838J.

For additional important information about serial numbers, see INSTRUMENTS IDENTIFICATION in Section I.

Manual Part No. 04271-90003
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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section contains general information about the Model 4271B 1MHz Digital LCR Meter. A general description plus information on specifications, accessories, and instrument identification is given.

1-3. SPECIFICATIONS.

1-4. Table 1-1 is a complete list of the Model 4271B critical specifications that are controlled by tolerances. Table 1-2 contains general information that describes the operating characteristics of the 4271B.

1-5. DESCRIPTION.

1-6. Automatic high speed, precision L, C, R, G and D Measurements are features of this new Model 4271B 1MHz Digital LCR Meter. Using a four-terminal pair measurement technique to minimize stray capacitance convenient for semi-conductors, capacitance measurements from 0,000pF to 19,000nF and inductance measurements from 000,0nH to 1900,0μH are easily made. Basic capacitance measurement accuracy is 0.1%. Readout is 4-1/2 digit LED display with 90% overrange. Capacitance loss components are measured as paralleled conductance (00,00μS to 190,00mS in 4 ranges) or dissipation factor (to 1,6000). Inductance loss components are measured as series resistance (0,000Ω to 19,000kΩ) or dissipation factor (to 1,6000). Selectable functions with loss components simultaneously displayed are C-D, C-G, L-D or L-R. Loss readout is 4-1/2 digit LED display. Capacitance measurement test voltages are 20mVrms - LOW, 500mVrms - HIGH and inductance test currents are 5mA to 2μA. DC bias variable from 00,0V to 39,9V in 0,1V steps is optional. Full interface compatibility with HP calculators and digital recorders completes the versatile Model 4271B. Typical applications are C and L measurements of discrete components in the laboratory or on the production line, semi-conductor measurements and L of C examinations of delay lines and pulse transformers.

1-7. INSTRUMENT IDENTIFICATION.

1-8. Hewlett-Packard uses a two-section nine character (0000J00000) or eight character (000-00000 or 000J00000) serial number. The first three or four digits (serial prefix) identify a series of instruments; the last five digits identify a particular instrument in

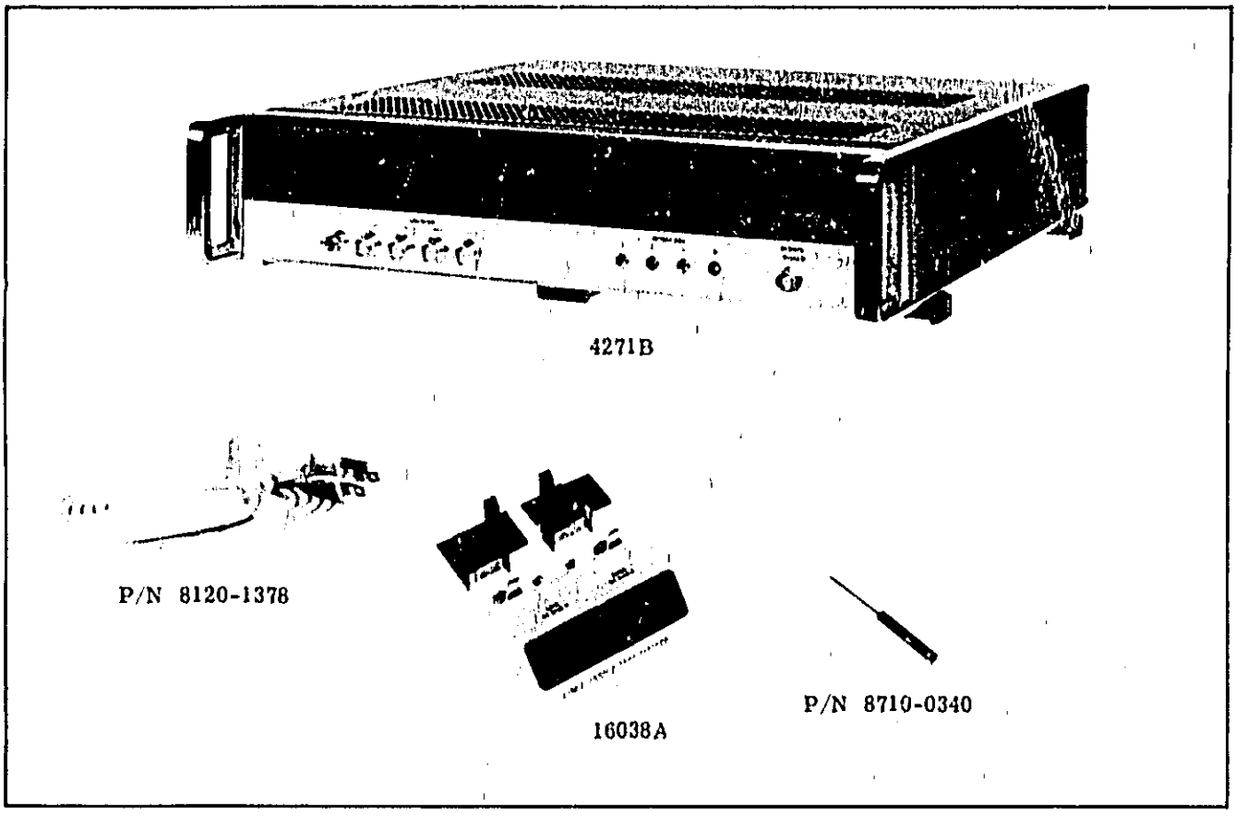


Figure 1-1. Model 4271B 1MHz Digital LCR Meter and Accessories.

Table 1-1. Specifications (Sheet 1 of 4).

Measurement Terminals: 4-terminal pair construction (current and potential terminals for both high and low sides).

Display: Dual 4-1/2 digit display, maximum display 19999 for C, G, L, R and 16000 for D (counts).

Test Frequency: 1MHz ±0.01%.

Ranging: Auto/Manual, remote control with Opt. 101.

External DC bias source: Provision for external DC bias voltage of ±200V maximum to BNC connector (EXT INPUT) on rear panel. Max. bias current 20mA. Input resistance 10.5kΩ ±10%.

Monitor output: Bias voltage monitoring BNC connector (monitor) on rear panel. Output resistance 470Ω ±10% to Hcur terminal.

CAPACITANCE MEASUREMENT

Parameters Measured: Capacitance and conductance (C-G) or capacitance and dissipation factor (C-D).

Equivalent Circuit: Capacitance in parallel with conductance.

Offset Adjustment: Offset ADJ. compensates for stray capacitance or residual conductance of test fixture. Variable ranges are 1pF and 1μS.

C Ranges and Accuracies

ITEMS		RANGE	1	2	3	4
FULL SCALE DISPLAY		C	19.999pF	199.99pF	1999.9pF	19.999nF
		G	199.99μS	1999.9μS	19.999mS	199.99mS
		D	1.999 on each range. Useable when C reading is more than 1500 counts.			
TEST SIGNAL LEVEL		HIGH	500mVrms ±10%			20mVrms ±10%
		LOW	20mVrms ±10%			
ACCURACY*	C	HIGH	± (0.1 + 2 reading ÷ counts)	± (0.1 + 3 reading ÷ counts)	± (0.1 + 2 reading ÷ counts)	± (0.1 + 3 reading ÷ counts)
		LOW	± (0.2 + 8 reading ÷ counts)	± (0.2 + 7 reading ÷ counts)	± (0.2 + 5 reading ÷ counts)	
	G	HIGH	$\pm\left(0.2+\left(4+\frac{1}{1000}\cdot N_c\right)\right)$	$\pm\left(0.2+\left(3+\frac{1}{1000}\cdot N_c\right)\right)$	$\pm\left(1.2+\left(2+\frac{7}{1000}N_c\right)\right)$	
		LOW	$\pm\left(0.3+\left(7+\frac{7}{1000}\cdot N_c\right)\right)$	$\pm\left(0.3+\left(5+\frac{2}{1000}\cdot N_c\right)\right)$		
	D	HIGH	$\pm\left(1.0+\left(10+\frac{20000}{N_c}\right)\right)$	$\pm\left(1.0+\left(10+\frac{10000}{N_c}\right)\right)$		$\pm\left(1.0+\left(15+\frac{50000}{N_c}\right)\right)$
		LOW	$\pm\left(1.0+\left(15+\frac{30000}{N_c}\right)\right)$	$\pm\left(1.0+\left(15+\frac{20000}{N_c}\right)\right)$		

*When conductance reading is less than 1000 counts. Warm-up time: One hour required to meet all specifications. Accuracy listed in above table applies over a temperature range of 23°C ±5°C (at 0°C to 50°C, accuracy is doubled) Nc means capacitance readout in counts. Accuracy check: HP Model 16021A Test Fixture should be used to prevent errors caused by improper connection to standard device.

Table 1-1. Specifications (Sheet 4 of 4).

OPTIONS

Option 001: Internal DC bias source.

Range: 00.0V to 39.9V, variable in 0.1V steps.

Accuracy: ±0.2% of setting ±5mV (when ambient temperature is 23°C ±5°C and warm-up time is more than 60 min.).

Output resistance: 1.5kΩ ±10%, bias voltage is applied to Hcur terminal.

Short circuit current: Less than 5mA.

Control: Controlled manually by HP 16023A DC bias controller (available extra) or by HP 9815A, 9825A, 9830A/B or 9845A calculators through HP-IB when OPT. 101 is installed.

Control input connector: HP P/N 1251-0143, 14-pin receptacle, (Amphenol 57-40140).

Mating Connector: HP P/N 1251-0142 (Amphenol 57-30140).

Option 002: BCD output for C/L.

Option 003: BCD output for G/R/D.

Option 004: BCD output for C/L and G/R/D (Alternately).

(Reference Information for BCD Output Options)

Output signal: 1-2-4-8 code, bit and digit-parallel. Data-4 1/2 digits, Polarity-1/2 digit, Annunciation Signal-1 digit, Decimal Point-1 digit and Unit-1 digit.

Level:

State	Level	Output Characteristics
Low	0 to 0.4V	Maximum Sink Current-16mA
High	4.2 to 5V	Output Impedance-300Ω

OPT 004 Uses Ground True.

Print Command: Positive pulse, +5V, approx. 35 μsec wide. Output impedance 300Ω.

Hold Off: Level +2.5V to 15V with an input impedance of 10kΩ.

Output Connector: HP P/N 1251-0087, 50-pin receptacle, (Amphenol 57-40500-375). Mating Connector HP P/N 1251-0086, (Amphenol 57-30500).

Option 101: Refer to IEEE STD 488-1975 Standard Digital Interface for Programmable Instrumentation.

Purpose: To provide HP-IB(Hewlett-Packard Interface Bus) interface capability.

Bus Function Capability:
- SH1: Source Handshake Function.
- AH1: Accept Handshake Function.
- T5: Basic Talker, Serial Poll, Talk Only and Unaddress if MLA Functions.
- L4: Basic Listener, and Unaddress if MTA Functions.
- SR1: Service Request Function.
- RL2: No Local Lockout.
- DT1: Device Trigger Function.

No other bus functions are provided.

Instrument Functions Controlled: FUNCTION, RANGE, Triggering, and DC Bias (when 4271B is equipped with Option 001 DC Bias).

Data Output Available:

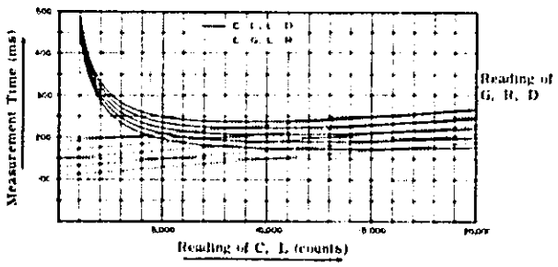
C - D, C - G, L - R, L - D, C and L.

Data Output Format:

C/L-D/G/R is serial form and C or L only.

Table 1-2. General Information.

How to determine measuring time: The following diagram shows time as a function of measured parameter and value when Range is fixed. When Auto Range is selected, a range selection time of 100msec/range step is added to time shown below.



To determine your measurement speed: Actual measuring time is dependent upon "C" or "L" reading and "D" or "R", "G" reading. To find actual measuring time proceed as follows:

1. Select one set of curves, C-D and L-D or G-G and L-R.
2. Determine "D" or "R" or "G" reading (in counts). Select one curve out of that is nearest to your reading.
3. Determine "C" or "L" reading (in counts). Locate on graph (horizontal axis).
4. The intersection of Steps 2 and 3 will give measuring time in msec (vertical axis of graph).

   If Autoranging is used, add 100msec/range change to the above measuring time.

Reading Rate: Reading rate is defined as the time required for one measurement cycle plus time interval between completion of a measurement cycle and the start of next cycle. The TRIGGER RATE control varies time interval between completion time of a measurement cycle and start of next cycle (5msec minimum/3sec maximum).

Remote/Manual Trigger: After completion of a measurement cycle, a new cycle may be started by pushing (manual) TRIGGER button or by remote trigger input to REMOTE TRIGGER connector.

Remote Trigger Input: A measurement cycle may be initiated at REMOTE TRIGGER Connector by changing logic level state from "0" (zero volts or connection to ground through less than 25Ω) to "1" (TTL high level or open), pulse width: ≥ 1μsec.

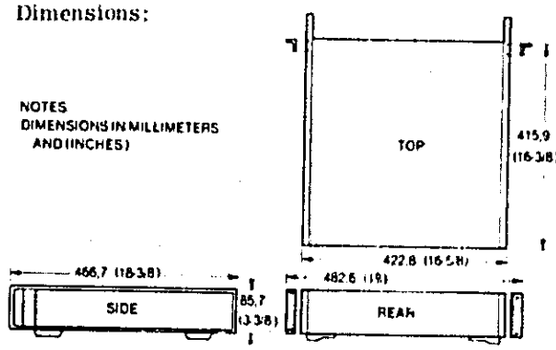
Manual Trigger Button: Releasing TRIGGER button (when depressed) initiated new measurement cycle.

Accessory Furnished: HP 16038A test fixture.

Operating Temperature and Humidity: 0°C to 50°C, relative humidity to 95% at 40°C.

Power: 100/120/220V ±10%, 240V +5% -10% 48 - 66Hz, 80VA Max.

Dimensions:



Weight: Approximately 10kg.

Table 1-4. Option Compatibility.

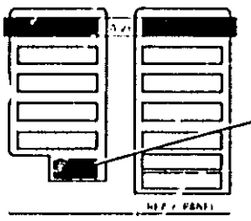
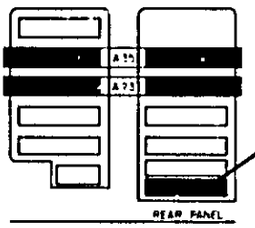
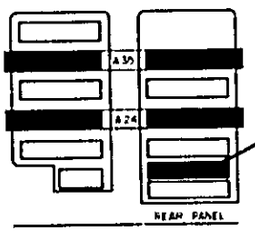
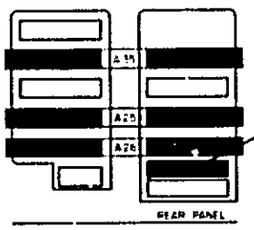
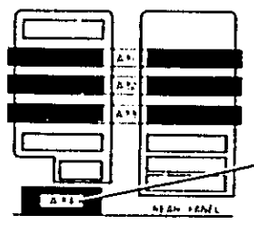
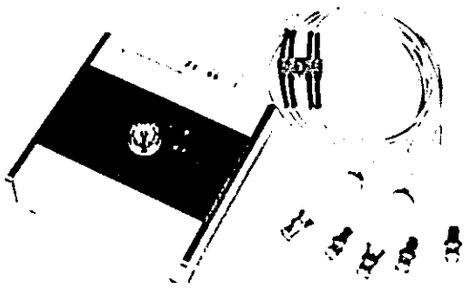
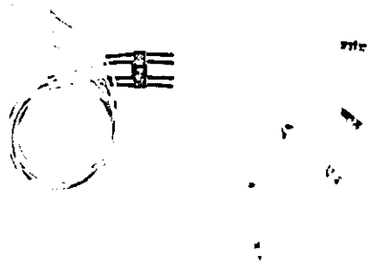
Option and Description	Option Board(s) & Location	Compatible with Option					Notes and Board P/N's
		001	002	003	004	101	
001 DC BIAS CONTROL		—	YES	YES	YES	YES	When Opt 001 is installed, bias control made by 16023A Bias Controller except when Opt 101 HP-IB is installed and the bias is controlled by the Bus (only). A21 DC Bias Supply P/N 04271-77227
		Mount P/N 04271-66560 Connector Board Assy. in rear panel opening (not used with Opt 101).					
002 C/L BCD OUTPUT		YES	—	YES	NO*	NO	A23 BCD Output P/N 04271-77229 A35 External Trigger P/N 04271-77238
		Mount P/N 04271-77225 Connector Board Assy in rear panel opening.			*Mechanically possible but not likely to be used with Opt 004.		
003 G/R/D BCD OUTPUT		YES	YES	—	NO*	NO	A24 G/R/D BCD Output P/N 04271-77230 A35 External Trigger P/N 04271-77238
		Mount P/N 04271-77224 Connection Board Assy in rear panel opening.					
004 C/L & G/R/D BCD SERIAL OUTPUT		YES	NO*	NO	—	NO	A25 Control Board P/N 04271-77231 A26 Decoder Board P/N 04271-77232 A35 External Trigger P/N 04271-77238
		Mount P/N 04271-77224 Connection Board Assy in rear panel opening.			*Mechanically possible but not likely to be used with Opt 002.		
101 HP-IB INTERFACE		YES	NO	NO	NO	—	A31 CPU Assy. P/N 04271-66551 A32 Control Assy. P/N 04271-66552 A33 Data Assy. P/N 04271-66553 A34 Connector Assy. P/N 04271-66554
		Mounted in rear panel.					

Table 1-5. Accessories Available.

Model 16021A Calibration Connector for Calibration of 4271B (Includes GR-900 connector).

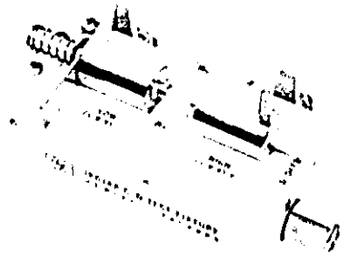


Model 16033A Test Leads - with small coaxial connector (HP P/N: 1250-0324).

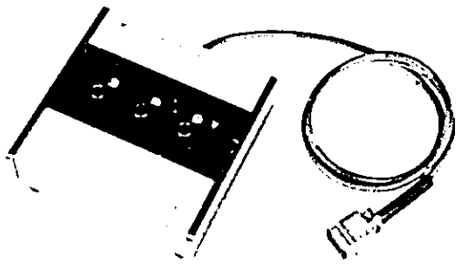


Model 16022A General Purpose Test Fixture

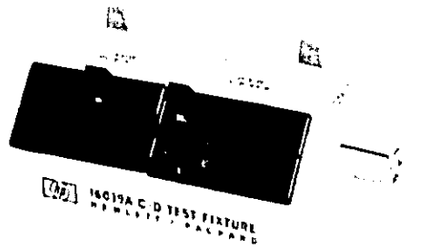
Model 16034A Test Fixture - for Chip Capacitor Measurement.



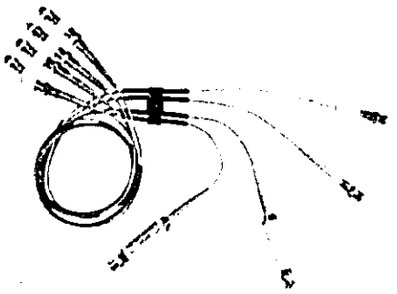
Model 16023A Bias Voltage Controller.

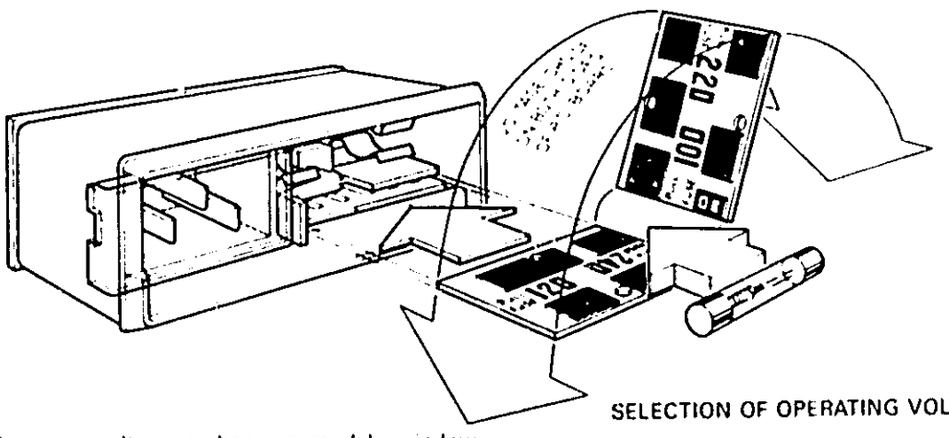


Model 16039A Test Fixture with D Offset Function.



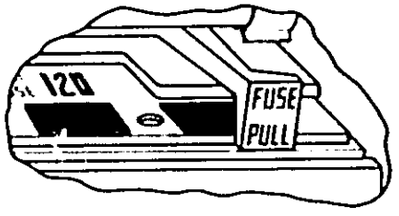
Model 16032A Test Leads - with BNC Connector.





SELECTION OF OPERATING VOLTAGE

Operating voltage is shown in module window and is usually set to 120V at factory.



1. Disconnect power cable and slide module window to left.
2. Pull FUSE PULL lever and rotate to left. This removes line fuse.
3. Select operation voltage by orienting PC board to position desired voltage on top-left side. Push board firmly into module slot.
4. Rotate FUSE PULL lever back into normal position and re-insert fuse in holders, using caution to select correct fuse value.

Operating Voltage	Fuse	
	HP Part No.	Description
100Vac or 120Vac	2110-0007	1 A 250V Slow Blow
220Vac or 240Vac	2110-0202	0.5A 250V Slow Blow

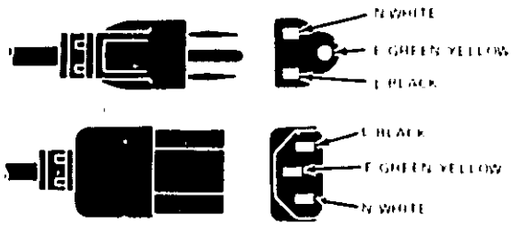
Figure 2-1. Voltage and Fuse Selection.

2-13. Figure 2-2 shows the available power cords, which may be used in various countries including the standard power cord furnished with the instrument. HP Part number, applicable standards for power plug, power cord color, electrical characteristics and countries using each power cord are listed in the figure. If assistance is needed for selecting the correct power cable, contact nearest Hewlett-Packard office.

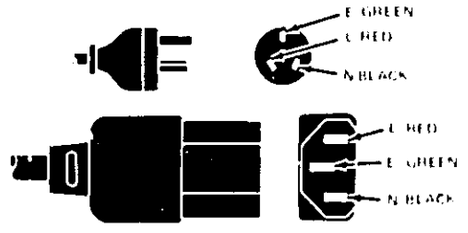
2-14. Operating Environment.

2-15. Temperature. The instrument may be operated in temperatures from 0°C to +50°C.

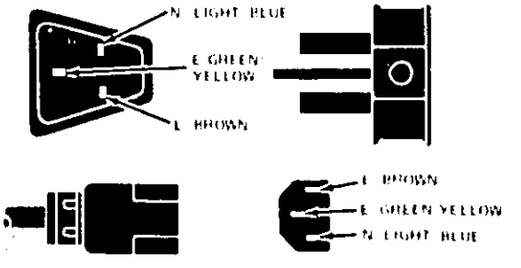
2-16. Humidity. The instrument may be operated in environments with relative humidities up to 95% at 40°C. However, the instrument should be protected from temperature extremes which cause condensation within the instrument.



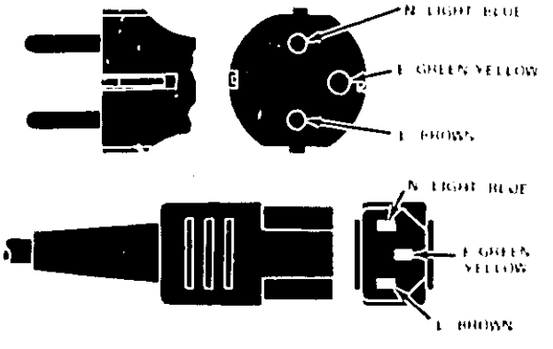
HP Part No. 8120-1378
NEMA 5-15P
Color: JADE GRAY
Furnished



HP Part No. 8120-1369
AS-C112, N.Z.S.S. 198
Color: GRAY
250V, 6A
for Australia, New Zealand, etc.



HP Part No. 8120-1351
BS 1363A
Color: MINT GRAY
250V, 5A
for Great Britain, South Africa, India, Rhodesia, Singapore, etc.



HP Part No. 8120-1689
CEE7-VII
Color: MINT GRAY
250V, 6A
for East West Europe, Brazil, Iran, Venezuela, Israel, etc.

Note E: Earth or safety ground.
L: Line of active conductor.
N: Neutral or identified conductor.

Figure 2-2. Power Cables.

2-17. RACK INSTALLATION.

2-18. The Model 4271B is ready for bench operation as shipped from the factory. Additional parts necessary for rack mounting are packaged with the instrument. To convert for rack installation, refer to Figure 2-3 and proceed as follows:

a. Remove tilt stand.

b. Remove feet (press the foot-release button, slide foot toward center of instrument, and tilt off).

c. Remove adhesive-backed plastic trims.

d. Attach trim strip along bottom edge of front panel.

e. Attach flanges to front end of sides (larger corner-notch toward bottom of instrument). Instrument is now ready to mount in standard rack.

CAUTION

AMBIENT TEMPERATURE IN RACK DURING OPERATION SHOULD NOT EXCEED A MAXIMUM OF 122°F(50°C) BE SURE INSTRUMENT POSITION IN RACK PERMITS AIR CIRCULATION. IF NECESSARY, USE BLANK PANELS (HP TYPES 12680B THRU 12685B).

2-19. STORAGE AND SHIPMENT.

2-20. Environment.

2-21. The instrument may be stored or shipped in environments within the following limits:

Temperature ..... -40° C to +75° C
Humidity ..... Up to 95%

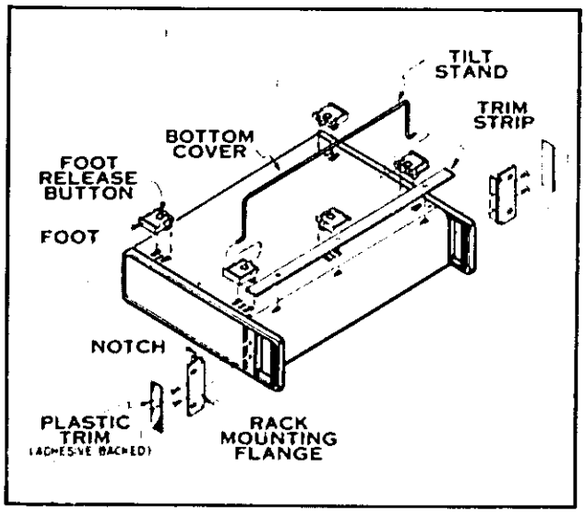


Figure 2-3. Conversion to Rack Mounting.

The instrument should be protected from temperature extremes which cause condensation inside the instrument.

2-22. Packaging.

2-23. Original packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-24. Other packaging. The following general instruction should be used for re-packing with commercially available materials:

a. Wrap instrument in heavy paper or plastic. If shipping to Hewlett-Packard office or service center, attach tag indicating type of service required, return address, model number, and full serial number.

b. Use strong shipping container. A double-wall carton made of 350 pound test material is adequate.

c. Use enough shock absorbing material (3 to 4 inch layer) around all sides of instrument to provide firm cushion and prevent movement inside container. Protect control panel with cardboard.

d. Seal shipping container securely.

e. Mark shipping container FRAGILE to ensure careful handling.

f. In any correspondence, refer to instrument by model number and full serial number.

2-25. OPTION INSTALLATION.

2-26. The following paragraphs describe how to install the 4271B Options in a standard 4271B unit. Firstly, perform the following for all option installations:

a. Disconnect power cable from 4271B instrument.

b. Remove top cover from instrument.

c. Perform the installation instructions as described in the following paragraphs for the desired option.

2-27. Option 001 Installation.

a. Insert A21 (P N: 04271-77227) board into option socket labelled "A21".

b. Remove blank plate covering "DC BIAS CONTROL" opening.

c. Mount connector board assembly (P N: 04271-66560) in opening.

2-28. Option 002 Installation.

a. Insert A23 (P/N: 04271-77229) and A35 (P/N: 04271-77238) boards into option sockets labelled "A23" and "A35" respectively.

b. Remove blank plate covering "C, L DATA OUTPUT" opening.

c. Mount connector board assembly (P/N: 04271-77225) in opening.

2-29. Option 003 Installation.

a. Insert A24 (P/N: 04271-77230) and A35 (P/N: 04271-77238) boards into option sockets labelled "A24" and "A25" respectively.

b. Remove blank plate covering "DATA OUTPUT" opening.

c. Mount connector board assembly (P/N: 04271-77224) in opening.

2-30. Option 004 Installation.

a. Insert A25 (P/N: 04271-77231), A26 (P/N: 04271-77232) and A35 (P/N: 04271-77238) boards into option sockets labelled "A25", "A26" and "A35" respectively.

b. Remove blank plate covering "DATA OUTPUT" opening.

c. Mount connector board assembly (P/N: 04271-77224) in opening.

2-31. Option 101 Installation.

a. Replace blank panel at rear panel with A34 Connector Ass'y (P/N: 04271-66554) as shown in Figure 2-4(a).

b. Connect A31 CPU Ass'y (P/N: 04271-66551), A32 Control Ass'y (P/N: 04271-66552), and A33 Data Ass'y (P/N: 04271-66553) together with flat cable A31W1 from A31 Ass'y.

c. Insert A31, A32 and A33 into specified option sockets as shown in Figure 2-4(b).

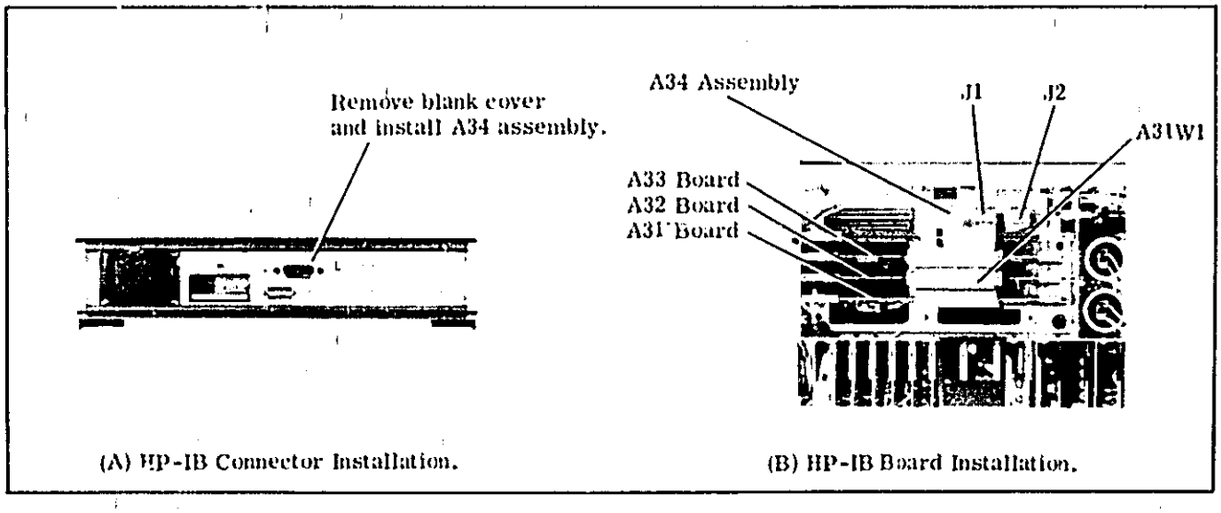
Note

Ass'y numbers (A31~A33) are labeled beside the option sockets.

d. Connect the IC type plugs at the end of the dual line flat cable from A31 board to the appropriate IC type sockets J1, J2 on A34 Connector Ass'y.

e. Turn instrument on.

f. Adjust A31R16 to set the dc voltage at the A31TP1 to the same as the voltage stamped on the ceramic case of the A31U15 IC (within ±5%).



(A) HP-IB Connector Installation.

(B) HP-IB Board Installation.

Figure 2-4. OPT. 101 Installation in 4271B.

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

that series. The letter between the two sections identifies country where instrument was manufactured. serial number appears on a plate located on rear panel. All correspondence with Hewlett-Packard Sales/Service Offices with regard to an instrument should include the complete serial number.

1-9. MANUAL CHANGES.

1-10. This manual provides operating and service information for the HP Model 4271B 1MHz Digital LCR Meter. The information in this manual applies directly to an instrument with the serial prefix or number indicated on the title page of this manual.

1-11. If the serial prefix of instrument is higher than that on the title page, the "Manual Changes" sheet supplied will describe changes which will adapt this manual to provide correct coverage. Technical corrections (if any) to this manual, due to known error in print, are called Errata and are shown on the change sheet.

1-12. If the serial prefix or number of an instrument is lower than that on the title page, see Section VII Manual changes. For information on Manual coverage of any HP instrument, contact the nearest Hewlett-Packard Sales/Service Office (addresses are listed at the rear of this manual).

1-13. OPTIONS.

1-14. The 4271B currently includes seven options given in Table 1-3 as follows:

Table 1-3. Options.

Option	Description
001	DC BIAS SUPPLY
002	C/L BCD OUTPUT
003	G/R/D BCD OUTPUT
004	PARAMETER SERIAL BCD OUTPUT
101	HP-IB INTERFACE
903	RACK MOUNT KIT
910	EXTRA MANUAL

1-15. Option 001 DC Bias Supply.

1-16. Option 001 provides a method for applying small increments (0.1V steps) of the internal bias voltage to the sample under test. Bias control is provided by external signal. This option can be controlled with Option 101, HP-IB Interface, or the Model 16023A accessory bias controller, but not with both.

1-17. Option 002 C/L BCD Output.

1-18. Option 002 C L BCD Output transfers the measured value of capacitance or inductance in a parallel BCD code with unit, value mautiplier, etc. to an external digital recorder.

1-19. Option 003 G/R/D BCD Output.

1-20. Option 003 G R D BCD Output transfers measured value of conductance, series resistance or dissipation factor in a parallel BCD code with unit, multiplication signals etc. to an external digital recorder which prints the data.

1-21. Option 004 Parameter Serial BCD Output.

1-22. Option 004 Parameter Serial BCD OUTPUT mutually transfers measured value of a capacitor or an inductor: C/L data and so on to an external digital recorder which prints them. Output of C/L only, G/R D only, or both is selected by a switch on A25 board.

1-23. Option 101 HP-IB Interface.

1-24. Option 101 HP-IB Interface provides interfacing functions to both transfer C L and G R D data to HP Interface-Bus line and to receive remote control signals from HP Interface Bus line.

1-25. Option 908 Rack Mount Kit.

1-26. Option 908 Rack Mount Kit provides mechanical parts necessary for rack mounting. Installation procedures for this option are detailed in Section II.

1-27. Option 910 Extra Manual.

1-28. Option 910 Extra Manual provides an extra copy of Operating and Service Manual.

1-29. Option Compatibility.

1-30. Table 1-4 shows overall option compatibility of the Model 4271B 1MHz LCR Meter.

1-31. ACCESSORIES SUPPLIED.

1-32. Figure 1-1 shows the HP Model 4271B LCR Meter, the HP Model 16038A (a direct connection type test fixture for general purpose measurements), power cable (HP Part No. 8120-1378).

1-33. ACCESSORIES AVAILABLE.

1-34. Table 1-5 shows accessories available. See Section III for use of these accessories.

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SECTION II
INSTALLATION

2-1. TRODUCTION.

2-2. This section provides installation instructions for the Model 4271B 1MHz Digital LCR Meter. The section also includes information on initial inspection and damage claims, preparation for using the 4271B, packaging, storage, and shipment.

2-3. INITIAL INSPECTION.

2-4. The 4271B 1MHz Digital LCR Meter, as shipped from the factory, meets all the specifications listed in Table 1-1. On receipt, inspect the shipping container for damage. If the shipping container or cushioning material is damaged, notify the carrier as well as the Hewlett-Packard office and be sure to keep the shipping materials for carrier's inspection until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1. The procedures for checking the general electrical operation are given in Section III and the procedures for checking the 4271B 1MHz Digital LCR Meter against its specifications are given in Section IV. If the 4271B 1MHz Digital LCR Meter is electrically questionable, then do the Performance Tests to determine whether the 1271B has failed or not. If contents are incomplete, if there is mechanical damage or defects (scraches, dents, broken switches, etc.), or if the performance does not meet performance tests, notify the nearest Hewlett-Packard office (see list at back of this manual). The HP office will arrange for repair or replacement without for claim settlement.

2-5. PREPARATION FOR USE.

2-6. Power Requirements.

2-7. The 4271B requires a power source of 100, 120, 220 Volts ac ±10%, or 240Volts ac +5% - 10%, 48 to 66Hz single phase. Power consumption is less than 80VA.

WARNING

IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN EXTERNAL AUTOTRANSFORMER FOR VOLTAGE REDUCTION, BE SURE THAT THE COMMON TERMINAL IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SUPPLY.

2-8. Line Voltage and Fuse Selection.

CAUTION

BEFORE TURNING THE 4271B LINE SWITCH TO ON, VERIFY THAT THE INSTRUMENT IS SET TO THE VOLTAGE OF THE POWER SUPPLIED.

2-9. Figure 2-1 provides instructions for line voltage and fuse selection. The line voltage selection card and the proper fuse are factory installed for 100 or 120 volts ac operation.

CAUTION

USE PROPER FUSE FOR LINE VOLTAGE SELECTED.

CAUTION

MAKE SURE THAT ONLY FUSES FOR THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE ARE USED FOR REPLACEMENT. THE USE OF MENDED FUSES AND THE SHORT-CIRCUITING OF FUSEHOLDERS MUST BE AVOIDED.

2-10. Power Cables.

2-11. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 4271B is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable is the ground wire.

2-12. To preserve the protection feature when operating the instrument from a two contact outlet, use a three prong to two prong adapter (HP Part No. 1251-0048) and connect the green pigtail on the adapter to power line ground.

CAUTION

THE MAINS PLUG MUST ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT PROTECTIVE CONDUCTOR (GROUNDING).

Table 1-1. Specifications (Sheet 2 of 4).

INDUCTANCE MEASUREMENT

Parameters Measured: Inductance and equivalent series resistance (L-R) or dissipation factor (L-D).

Equivalent Circuit: Inductance in series with resistance.

Offset Adjustment: Offset Adj. compensates for residual inductance or residual resistance of test fixture. Variable ranges are 100nH and 100mΩ.

L Ranges and Accuracies

ITEMS		RANGE	1	2	3	4
FULL SCALE DISPLAY		L	1000.0mH	10.000μH	100.00μH	1000.0μH
		R	10.000Ω	100.00Ω	1000.0Ω	10.000kΩ
		D	1.000 on each range. Useable when L reading is more than 1500 counts.			
TEST SIGNAL LEVEL		HIGH	2mArms ± 20%	5mArms ± 10%	500μArms ± 10%	50μArms ± 10%
		LOW		200μArms ± 10%	20μArms ± 10%	2μArms ± 10%
ACCURACY*	L	HIGH	± % reading ± counts: 1.0 + 15	± % reading ± counts: 0.6 + 1	± % reading ± counts: 0.2 + 1	
		LOW		0.6 + 6	0.3 + 6	
	R	HIGH	$1.2 + \left(8 + \frac{2}{1000} \cdot N_L\right)$	$1.2 + \left(2 + \frac{2}{1000} \cdot N_L\right)$	$0.3 + \left(2 + \frac{2}{1000} \cdot N_L\right)$	
		LOW			$0.\cdot + \left(2 + \frac{2}{1000} \cdot N_L\right)$	
	D	HIGH	$1.0 + \left(20 + \frac{50000}{N_L}\right)$	$1.0 + \left(15 + \frac{10000}{N_L}\right)$		$1.0 + \left(15 + \frac{20000}{N_L}\right)$
		LOW		$1.0 + \left(20 + \frac{20000}{N_L}\right)$		$1.0 + \left(20 + \frac{50000}{N_L}\right)$

*When resistance reading is less than 1000 counts.
Warm-up time: One hour required to meet all specifications. Accuracy listed in above table applies over a temperature range of 23°C ±5°C (at 0°C to 50°C, accuracy is doubled). N_L means inductance readout in counts.
Accuracy check: HP Model 16021A Test Fixture should be used to prevent errors caused by improper connection to standard device.

Table 1-1. Specifications (Sheet 3 of 4).

CONDUCTANCE/RESISTANCE MEASUREMENT

Note

1. Measurement accuracy of capacitance or inductance accompanied by other very small parameters (conductance or resistance) is described in capacitance measurement or inductance measurement. Measuring accuracy specifications for conductance or resistance is given for capacitance or inductance readings of less than 1000 counts.

2. The specifications of parameters measured, measuring circuit, measuring range, offset adjust and measuring signal are the same for both capacitance measurements and inductance measurements.

Accuracy listed in table applies over a temperature range of 23°C ±5°C (at 0°C to 50°C, accuracy is doubled). Warm-up time: one hour required to meet all specifications. Accuracy check: HP Model 16021A Test Fixture should be used to prevent errors caused by improper connection to standard device.

G & R Ranges and Accuracies

ITEMS		RANGE	1	2	3	4
G	FULL SCALE DISPLAY		[illegible]	[illegible]	[illegible]	[illegible]
	TEST SIGNAL LEVEL	HIGH	[illegible]	[illegible]	[illegible]	[illegible]
		LOW	[illegible]	[illegible]	[illegible]	[illegible]
	ACCURACY	HIGH	[illegible]	[illegible]	[illegible]	[illegible]
		LOW	[illegible]	[illegible]	[illegible]	[illegible]
R	FULL SCALE DISPLAY		[illegible]	[illegible]	[illegible]	[illegible]
	TEST SIGNAL LEVEL	HIGH	[illegible]	[illegible]	[illegible]	[illegible]
		LOW	[illegible]	[illegible]	[illegible]	[illegible]
	ACCURACY	HIGH	[illegible]	[illegible]	0.5 + [illegible]	
		LOW	[illegible]	[illegible]	0.5 + [illegible]	

ACCESSORIES AVAILABLE

16021A: Test fixture for checking accuracy of 4271B.

16022A: Test fixture. Axial lead insert stored in bottom compartment. For general purpose component measurement.

16023A: DC bias controller for use with OPT. 001. Controls DC bias.

16032A: Test leads with BNC connectors for use with your test fixture.

16033A: Test leads with miniature coaxial connectors for use with your test fixture.

16034A: Test fixture for chip capacitors.

16038A: Test fixture for general purpose component measurement. Two pairs of inserts (for axial and vertical lead components). Furnished accessory.

16039A: Test fixture for "D" offset. Two pairs of inserts (for axial and vertical lead components).

Table 3-8. Data Format (OPT.004).

Column				
8	7	6	5	4, 3, 2, 1
Unit	Magnification of Data	Warning Signal	Data or Symbol	Data

Unit (Column 8)

4271B Display	Connector Pin				Printed letter
	15	16	40	41	
pF	L	H	H	H	1
nF	L	L	H	H	3
nH	L	H	L	H	5
μH	L	L	L	H	7
D	H	H	H	H	0
μS	H	L	H	H	2
mS	H	H	L	H	4
Ω	H	L	L	H	6
kΩ	H	H	H	L	8

Data or Symbol (Column 5)

4271B Display	Connector Pin				Printed letter
	9	10	34	35	
1	L	H	H	H	1
-	L	L	H	L	-
Blank	L	L	L	L	*

Magnification of Data (Column 7)

4271B Display	Connector Pin				Printed letter
	13	14	38	39	
000.0 (10^{-1})	L	H	H	H	1
00.00 (10^{-2})	H	L	H	H	2
0.000 (10^{-3})	L	L	H	H	3
.0000 (10^{-4})	H	H	L	H	4

Data (Column 1 - 4)

4271B Display	BCD				Printed letter
	1	2	4	8	
0	H	H	H	H	0
1	L	H	H	H	1
2	H	L	H	H	2
3	L	L	H	H	3
4	H	H	L	H	4
5	L	H	L	H	5
6	H	L	L	H	6
7	L	L	L	H	7
8	H	H	H	L	8
9	L	H	H	L	9

Warning Signal (Column 6)

4271B Display	Connector Pin				Printed letter
	11	12	36	37	
"OUT OF RANGE" or "UNBAL"	H	H	L	L	V
"D→G, R"	L	H	L	L	A
Blank	L	L	L	L	*

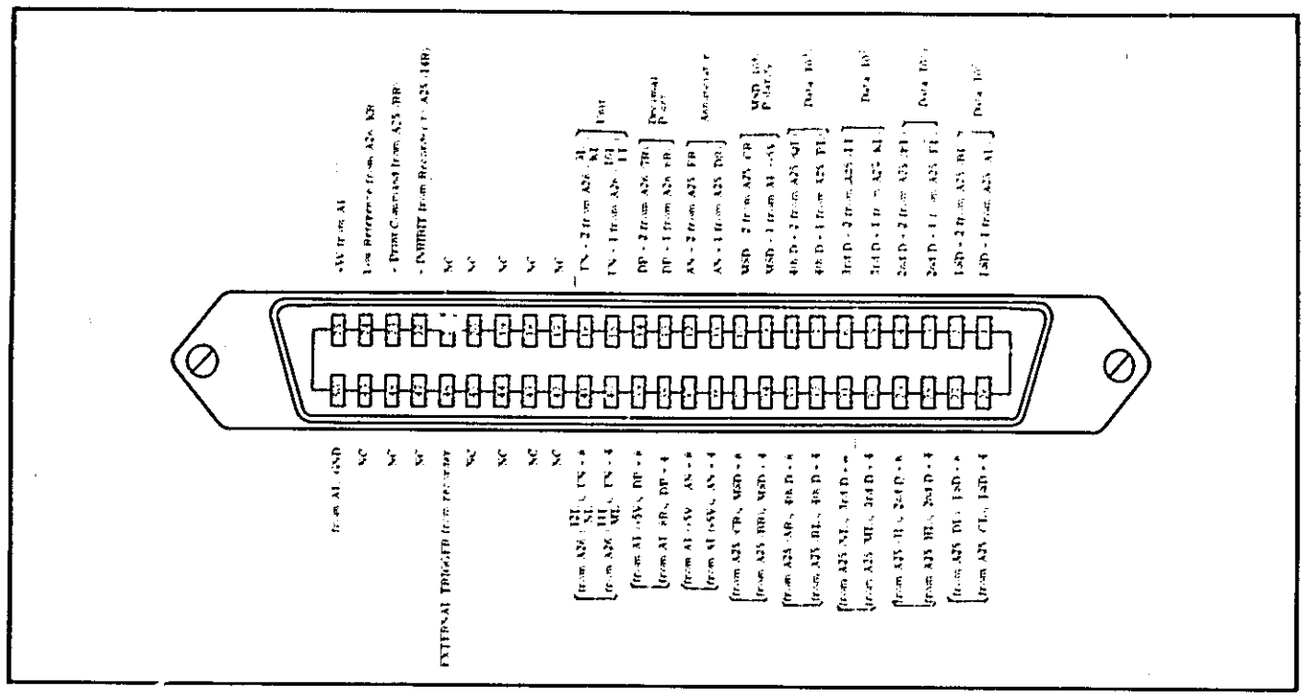
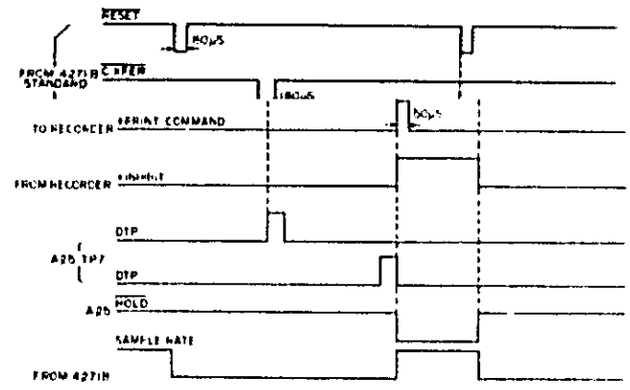
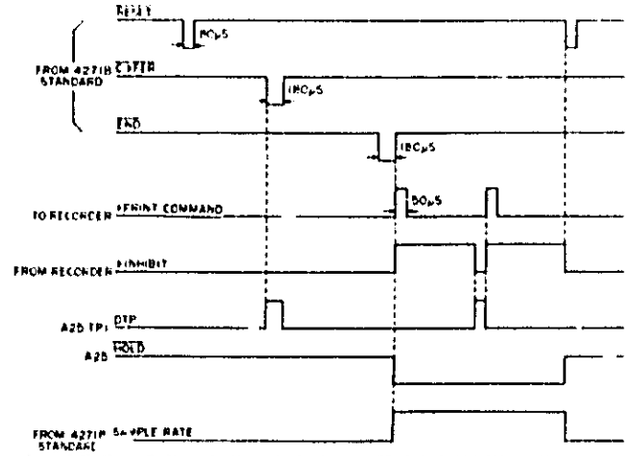


Figure 3-17. Connector Pins and Signals (OPT. 004).



(a) Transfer of C or L, or G or R or D data (A25S1 POSITION C or G).



(b) Transfer of C G or C D or L R or L D data (A25S1 POSITION C G).

Figure 3-18. Timing Diagram (OPT. 004).

3-94. Setting the Listen and Talk Addresses.

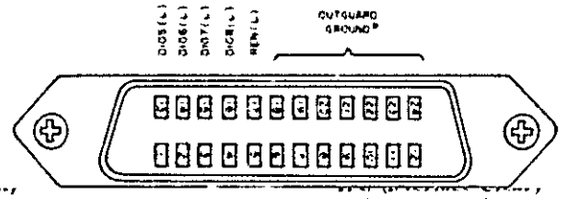
3-95. The controller may address either a listener or a talker by sending the proper listen or talk address. If two or more instruments are to be operated on the same interface bus line, they can have the same listen address but if they are to function as a talker, they must have a separate address. The address is established by positioning the first five sections (A1 through A5) of the HP-IB control switch on the rear panel (see example in Figure 3-23). Note that one set of these 5 bit positions identifies both a listen and talk address. Two additional bits (the 6th and 7th) are added by the calculator to tell the device whether it is being addresses as a listener or as a talker (01 for listen and 10 for talk). Thus, for example, with the HP 9825A or 9830A Programmable Calculators, the device address is simply the ASCII character representation of a seven bit binary code. Therefore, the ASCII character uniquely identifies the complete address of a device. Table 3-9 lists the 31 permissible address codes that may be used on the HP-IB.

CAUTION

THE "TALK ONLY-ADDRESSABLE" SWITCH SHOULD BE SET TO "ADDREESABLE" WHENEVER A CALCULATOR IS BEING USED TO CONTROL THE BUS. LIKEWISE, THE "HOLD" SWITCH SHOULD BE SET TO ITS NON-HOLD POSITION (0).

3-96. Talk Only (no controller).

3-97. The 4271B Option 101 may be used to supply measurement data direct to a digital printer or other data processing equipment without having a calculator (controller) on the bus. For this kind of system configuration, the TALK/ONLY/ADDRESSABLE switch in the group of HP-IB control switches on the rear panel is set to its TALK ONLY position. The HOLD



The eight "Data Input, Output" lines. The DIO lines transfer messages in a byte-serial, bit parallel manner.

EOI (End or Identify)
"End or Identify" control line. EOI is used by a device to indicate the end of a multiple-byte transfer.

DAV (Data Valid)
"Data Valid" control line. DAV is used to coordinate the "handshake" sequence. The DAV line is controlled by the source (talker). When DAV is true, data on the DIO lines is considered valid.

NRFD (Not Ready For Data)
"Not Ready For Data" control line. NRFD is used to coordinate the "handshake" sequence. The NRFD line is controlled by the acceptor (listener). When NRFD is false, the acceptor indicates to the source that he is ready to accept data.

NDAC (Not Data Accepted)
"Not Data Accepted" control line. NDAC is to used to coordinate the "handshake" sequence. The NDAC line is controlled by the accepter (listener). When NDAC is false, the acceptor indicates to the source that the data on the DIO lines has been accepted.

"Interface Clear" control line. IFC is used to place the HP-IB system in a known quiescent state. The IFC line is controlled by the system controller.

SRQ (Service Request)
"Service Request" control line. SRQ is used (by any device having service request capability) to indicate to the system controller that the device require service. The controller responds by polling the devices to determine which device requested service.

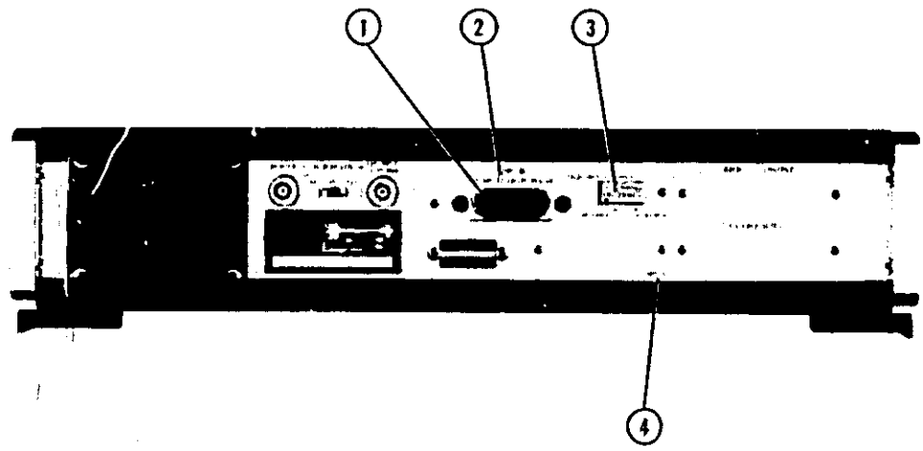
ATN (Attention)
"Attention" control line. The state of the ATN line determines whether the HP-IB is in the "command mode" (ATN true) or the "data mode" (ATN false). When ATN is true, all devices must listen to the data lines, and when ATN is false, only devices that have been addressed will actively transfer data.

REN (Remote Enable)
"Remote Enable" control line. REN is used in conjunction with listen address (DIO 1-8) to select either local or remote control of each device.

Outguard ground is isolated from inguard circuit common (input LOW terminal) and chassis (power line) ground and may be floated a maximum of 40V above chassis.

For further information concerning the HP-IB, refer to "Hewlett-Packard Interface, A Compendium of Technical Articles" -hp-publication No. 5952-2472.

Figure 3-20. Hewlett-Packard Interface Bus Connector (A34J4).



4271B Opt 101 Rear Panel

and for transmitting data from the 4271B to the bus.

2. Markings above HP-IB connector indicate instrument functional capabilities as an HP-IB device. Labelling is compatible with IEEE Std 488-1975:

Allowable Subset	Function
SH1	Source Handshake
AH1	Acceptor Handshake
T5	Talker
L4	Listener
SR1	Serial Poll
RL2	Remote Local
DT1	Device Trigger

3. Control Switch (also see Figure 3-23). A seven section switch which provides the following:

b. HOLD Section. Switch A6 is set to HOLD (1) when the instrument is being used in the TALK ONLY mode (when being used with a peripheral such as a digital recorder with no controller on the bus). This switch inhibits internal triggering in the 4271B. The effect is to slow the 4271B down to the trigger rate of the peripheral.

c. TALK ONLY/ADDRESSABLE Section. Switch A7 is set to TALK ONLY when the instrument is to serve as a talker only (usually without a controller but with a peripheral such as a digital recorder). The switch is set to ADDRESSABLE when a controller is controlling bus operation.

4. Opt 101 labelling indicates that unit is equipped for use as an HP-IB system device.

Note

See Figure 3-1 for standard rear panel features.

Figure 3-21. Rear Panel HP-IB Features.

Table 3-10. HP-IB Program Codes.

	Setting or Control	Program Code
FUNCTION	C - D	F1
	C - G	F2
	L - R	F3
	L - D	F4
RANGE	AUTO	R0
	1	R1
	2	R2
	3	R3
	4	R4
TRIGGER	Execute Trigger	E
DC BIAS note 1	0.0V - 39.9V	V000 ~ V399 note 2
Mode of Operation	No interrupt mode	N
	interrupt mode	I

Note 1: Option 001 DC Bias is required.
Note 2: Program code for DC Bias consists of the alpha "V" and 3 digits of numerals

3-98. 4271E OPT 101 Program Codes.

3-99. Table 3-10 HP-IB Program Codes lists the program codes designed into the Option 101 HP-IB circuitry for a Model 4271B. Subsequent paragraphs including paragraphs 3-100 through 3-102 Output Format and 3-110 through 3-112 Programming the 4271B Opt 101 describe the output formats and tell how the program codes are used to control the 4271B so the instrument outputs the desired data on the HP-IB.

3-100. Data Output Formats.

3-101. Output sequence descriptions for both basic formats (C and L, and D, G, or R) are as follows:

a. Capacitance or inductance —

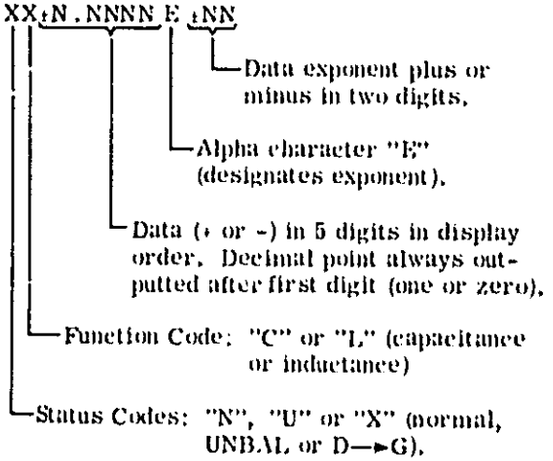


Table 3-11. HP-IB Interface Capability.

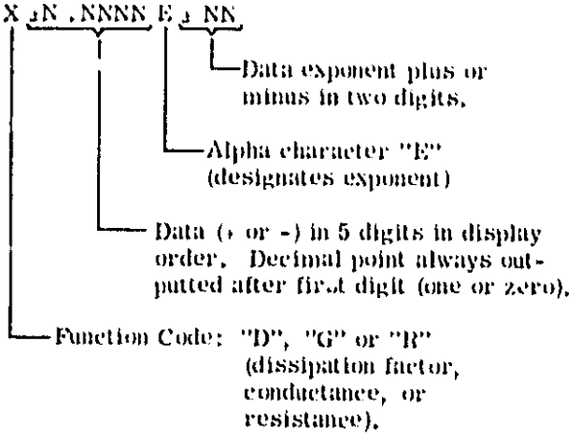
Code	Interface Function
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T5	Talker (basic talker, serial poll, talk only mode, unaddress to talk if addressed to listen)
L4	Listener (basic listener, unaddress to listen if addressed to talk).
SR1	Service Request Capability
RL2	Remote/Local Capability (no local lock out).
PP0	No Parallel Poll Capability
DC0	No Device Clear Capability
DT1	Device Trigger Capability
C0	No Controller Capability
Note: Interface Functions provide the means for a device to receive, process and send messages over the bus.	

Status Codes:

N (normal): Instrument measurement conditions satisfactory (e.g. appropriate ranges and modes) are not appropriate.

X (D—►G): "D—►G" annunciator lit signals the need to change FUNCTION programming (e.g. from C-D to C-G, etc.) to get a more accurate measurement.

b. Dissipation factor, conductance and resistance:

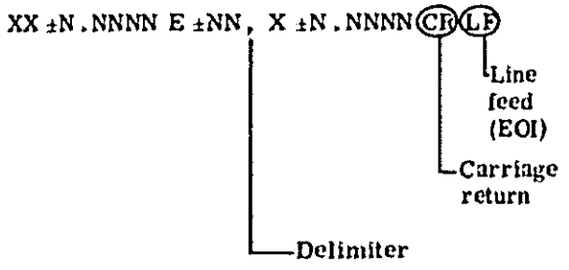


3-102. Three output formats are possible with the 4271B - Opt 101:

a. Format A.

To output either C-D, C-G, L-R or L-D in a

continuous string, the C, L (capacitance/inductance) switch is set to its "all data" position and the CR/LF (carriage return/line feed) switch on A33 board is set to its "off" position (see Figure 3-24). In this mode, data is output in the following format:



Note

The 4271B Opt 101 is set at the factory for output Format A.

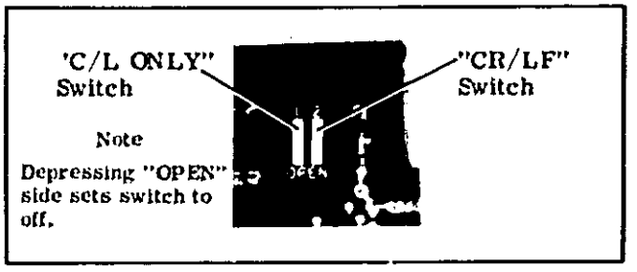


Figure 3-24. "C/L ONLY" and "CR/LF" Switches on A33 Data Board.

Table 3-12. Bus Messages.

Functions	Message	Description
Device Communications	Data	Transfers device-dependent information from one device to one or more devices on the Bus.
Device	Trigger	Causes a group of selected devices to simultaneously (a certain range, function, etc.).
	Remote	Permits selected devices to be set to remote operation, allowing parameters and device characteristics to be controlled by Bus Messages.
	Local	Causes selected devices to return to local (front panel) operation.
	Local Lockout	Disables local (front panel) controls of selected devices.
	Clear Lockout and Local	Returns all devices to local (front panel) control and simultaneously clears the Local Lockout Message.
Interrupt and Device Status	Requires Service	Indicates a device's need for interaction with the controller.
	Status Byte	Presents status information of a particular device; one bit indicates whether or not the device currently requires service, the other 7 bits (optional) are used to indicate the type of service required.
	Status Bit	A single bit of device-dependent status information which may be logically combined with status bit information from other devices by the controller.
Passing Control	Pass Control	Passes bus controller responsibilities from the current controller to a device which can assume the Bus supervisory role.
Bail Out	Abort	Unconditionally terminates Bus communications and returns control to the system controller.

3-108. When triggered by a bus signal, the 4271B with take a measurement and, in accord with the proper bus logic, will output measurement data on the bus lines to the controller or other selected listener.

3-109. HP-IB program codes for a 4271B Opt 101 instrument are given in Table 3-10.

3-110. Programming Instructions.

3-111. General. Remote programming of the 4271B Opt 101 first requires a thorough knowledge of using instrument capabilities under normal operation. After all, and for the most part, remote programming merely substitutes a program code for manual operation of instrument controls.

3-112. Bus communications. The major portion of communications transmitted over the Bus is accomplished by data messages. Data messages are used by the controller to program the Model 4271B Opt 101 and are used by the 4271B Opt 101 to transmit measurement data. These functions are explained in the following paragraphs. The 4271B Opt 101 is programmed by means of data messages sent over the Bus from the controller. These messages are composed of two parts: the address command contains the "talk" and "listen" addresses of the controller
[illegible] to the controller manual. Syntax for the program information portion consists of the program codes listed in Table 3-10.

3-113. Modes of Operation.

Note

The "No Interrupt" and "Interrupt" modes discussed below are peculiar for interfacing various devices that function at different speeds. For exam , the "Interrupt" mode permits a device on the bus to interrupt the controller when it (the device) has information to send over the bus. At this point the controller (calculator or computer) may wait for the device to transmit its data or may continue programming and return later to acquire data from device.

3-114. No Interrupt Mode
(addressed single with output).

3-115. The 4271B Opt 101 takes one readi , if addressed to talk on the bus. If not addressed to talk, it waits for its talk address to output or its listen address to be programmed. After outputting the reading data, a new reading is initiate by reprogramming the ASCII or by going to local control. If programming occurs before output of the reading data, a new reading will be taken according to the new programming data.

3-116. Interrupt Mode
(interrupt single with output).

3-117. This mode is same as No Interrupt Mode except that if the instrument is not addressed to talk, it will pull Service Request Line (SRQ) to Low after each data reading is taken. This line is taken HIGH after output of reading data or when new programming data is received.

3-118. Panel Switch Settings for HP-IB Operation.

3-119. Since LLO (local lockout) is not used in the 4271B Opt 101 instrument, the front panel FUNCTION, RANGE and TRIGGER switches must be set to their REM (remote) positions to permit the instrument to be controlled by HP-IB messages. In addition, the TEST SIG LEVEL switch (LOW or HIGH) must be set manually to the desired position. If Opt 001 DC BIAS is installed, dc bias from 0 to 39.9 volts dc in 0.1 volt steps can also be controlled by bus messages (see paragraph 3-132) DC Bias Operation).

[illegible] trolled on the bus by program code sets. Programming codes for the 4271B Opt 101 are given Table 3-10. These codes are ASCII characters consisting of a set of letters, numbers, and characters. The set of program codes in a list of all instrument functions that are remotely programmable (as in Table 3-10 for the 4271B Opt 101). The instrument offers a choice of remotely controlling the measurement functions in the interrupt or no-interrupt modes (see paragraphs 3-113 through 3-117).

3-122. Literals and Variable Values.

3-123. Program codes may be seprated into two categories - literals and variable values. Literals typically program discrete functions of a device. Variable values usingly control instrument settings that it is desired to change from time-to-time (e.g. dc bias).

3-124. Program Coding by Literals.

3-125. Instrument functions are controlled by using literal program codes (a code pair consits of a letter and a numeral) as given in Table 3-10. The letter identifies the kind of function to be selected and the numeral defines the action within the function which is to be set. This program coding is provided for controlling the functions with a calculator program. Refer to Figure 3-25 for programming.

3-126. Program Coding by Variable Values.

3-127. Instrument functions can also be controlled by using variable values instead of numerals as in literal program coding. Program coding for controlling functions with variable values is done by using numerals selected from the keyboard, from variables stored in the calculator memory, or from the calculator program. Refer to Figure 3-26 or programming.

3-128. Receiving Data.

3-129. To receive and store the measured data from the 4271B Opt 101 (in the output format form described in paragraphs 3-100 through 3-102), 2 registers are required. Refer to Figure 3-27 for programming.

3-130. Operation.

3-131. To operate the 4271B Opt 101 1MHz Digital LCR meter follow the procedures given in Figure 3-30. Sample programs in the no-interrupt and interrupt modes are given in Figures 3-28 and 3-29.

3-132. DC Bias Operation.

3-133. When a Model 4271B Opt 101 1MHz Digital LCR Meter is also equipped with Opt 001, dc bias to the DUT (device under test) may be controlled by Bus messages. Figure 3-31 is a sample dc bias control program for the HP 9825A Calculator.

Note

When the 4271B is equipped with both Option 101 (HP-IB) and 001 (DC BIAS), the connector to the Model 16023A Bias Controller is removed as control is now done via remote control on the Bus.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. In this section, the operation of the Model 4271B 1MHz Digital LCR Meter is described and certain recommended operating considerations are treated. The section includes an explanation of front and rear panel controls and connectors, major operating characteristics, operating procedures for the 4271B (and its options) and other required information for effective use of the instrument.

3-3. APPLICATIONS.

3-4. The Model 4271B accurately measures the capacitance, inductance, resistance, conductance and dissipation factors of capacitors and inductors in general use. While the 4271B has a very wide range of application, it is particularly suitable for measurement of capacitances of semiconductor devices, especially a variable capacitance diode. The instrument also provides for measurement applications requiring a DC bias voltage and for processing and recording the measured data. Thus, a wide variety of available features increase the applications versatility of the instrument.

3-5. MEASURING LIMITS.

3-6. The measuring limits of the 4271B are shown in Table 1-1 Specifications. However, as you will learn from a study of the operation of the instrument, the specifications do change depending upon settings of FUNCTION and TEST SIG LEVEL of 4271B. These measuring limits should be well understood when measuring a sample with the 4271B. Measurements taken which are beyond these limits are ambiguous as measured values.

3-7. FRONT/REAR PANEL DESCRIPTIONS.

3-8. Descriptions of both front panel and rear panel controls, functions and connectors are given in Figure 3-1. The understanding of these controls and functions is essential for obtaining correct measurements with the 4271B.

Note

Front/rear panel descriptions for the Option 101 instrument are described in paragraph 3-90 (see Figures 3-21 and 3-22).

3-9. PREOPERATION.

3-10. Before LINE switch is turned to ON and measurements attempted, perform following procedures:

a. Check line voltage selection card in power module on the rear panel. Set selection card to correct position for local AC line voltage. Install fuse of proper current rating (refer to paragraph 2-8).

b. Connect power cord to instrument. When using an outlet without GROUND terminal, a connector adapter (HP P/N 1251-0048) should be used for safety.

c. Set front panel controls as follows:

FUNCTION ..... C-G
RANGE ..... AUTO
TEST SIG LEVEL ..... LOW
RATE ..... centered
TRIGGER ..... INT
DC BIAS VTG (on rear panel) .... OFF
LINE ..... OFF

d. Turn LINE switch to ON. For accurate measurements allows a warm-up time of $\geq$ 60 min. During this time the measuring rate lamp will periodically turn on and off.

CAUTION

WHEN FUNCTION IS SET TO L-R OR L-D AND RANGE IS SET TO AUTO, DO NOT LEAVE FOUR TERMINALS OPEN WITHOUT A TEST FIXTURE CONNECTED.

CAUTION

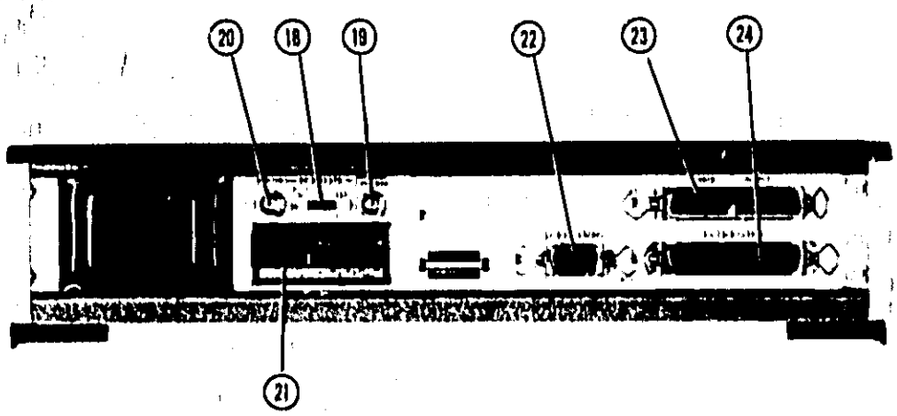
IF A TEST FIXTURE OR A TEST CABLE IS NOT CONNECTED, THE FOUR TERMINAL PAIR IS NOT COMPLETED, AND COUNTER AND ANNUNCIATORS WILL DISPLAY AMBIGUOUS READINGS. THIS IS NOT A TROUBLE.

e. Set OFFSET adjustment as required for sample being measured. Refer to paragraph 3-13.

f. Connect sample to test fixture or to test leads. Read display.

3-11. CONNECTION OF DUT (Device Under Test).

3-12. The unknown terminals are H_{CUR}, L_{CUR}, H_{POT} and L_{POT} which configure a four-terminal pair measurement arrangement as shown in Figure 3-2. When a four-terminal pair connection arrangement is employed, current flow from H_{CUR} terminal through DUT to L_{CUR} terminal does not generate a magnetic field around the test cables since current is supplied through the center conductor coaxial cable and returns through its outer conductor. Thus an emf which might cause an error is not generated in the potential cables (voltage leads). This permits accurate measurements (e.g. even with very small inductances) without the influence of measurement cables. In practice, the four-terminal pair is converted to a 3-terminal or to a 2-terminal near the DUT. The residual impedance and stray admittance



11. OFFSET ADJ. Compensates for residual inductance, resistance, stray capacitance or residual conductance of test fixture. The variable ranges are approximately 1pF, 1 μS, 100nH and 0.1Ω.

12. TRIGGER (INT, RMT/MAN). Selects triggering mode of measurement cycle. INT is internal triggering. RMT/MAN is for remotely controlled triggering or for manual (pushbutton) triggering.

13. RATE. Selects the repetition rate of measurement. Maximum rate is in full clockwise position.

14. Trigger Button (Manual). For Manual triggering. When this button is pushed, measurement is held. When button is released, instrument is triggered.

15. REMOTE TRIGGER. Connector for external triggering fixture.

16. LINE (OFF/ON). AC Power Switch.

17. Ground. Instrument ground terminal.

18. DC BIAS VTG (INT/OFF/EXT). Selects bias mode. INT is for internal bias by 4271B with Option 001. EXT is for external bias. OFF is for no bias.

19. DC Bias Input (EXTERNAL). Input connector for external bias voltage. Maximum input ±200Vdc.

20. DC Bias MONITOR. Connector for DC bias voltage monitoring. If necessary to monitor voltage across DUT (device under test) use a DVM, float input and connect DVM ground to 4271B ground terminal.

21. AC Power Input. AC receptacle. Accepts female connector. Voltages of 100, 120, 220V (±10%), or 240V (+5% - 10%) may be used (set voltage selection card to correct position).

22. DC BIAS CONTROL. Input Connector (J10). Input connector for internal bias (OPT 001) control. (For details see paragraph 3-75).

23. DATA OUTPUT Connector (J11). Output connector for options 003, 004. (For details see paragraphs 3-81 and 3-82).

24. C, L DATA OUTPUT Connector (J12). Output connector for option 002. (For details see paragraph 3-80).

Figure 3-1. Front and Rear Panels (sheet 2 of 2).

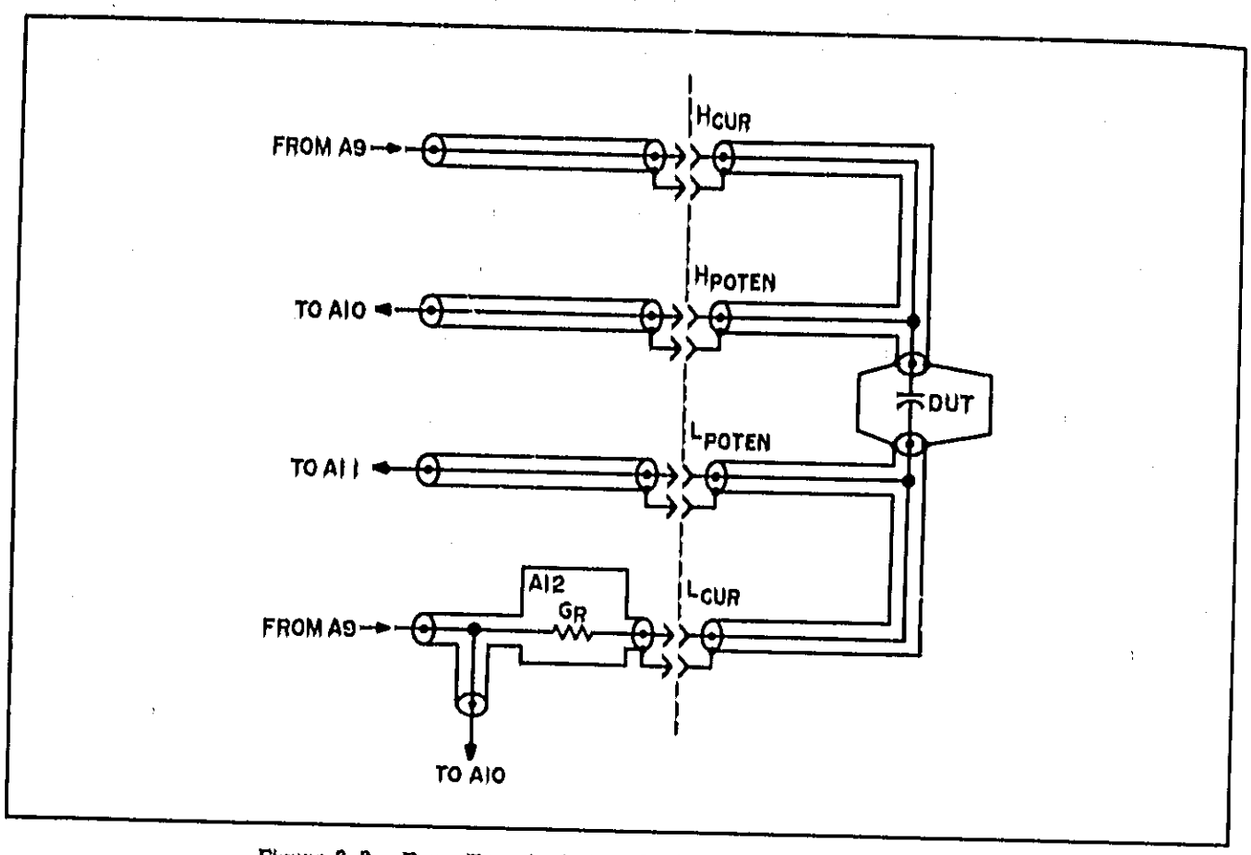


Figure 3-2. Four-Terminal Pair Configuration (C Measurements).

which remain in part of the connection after conversion can be compensated for by the offset adjustment (described later).

3-13. OFFSET ADJUSTMENT.

3-14. The Model 4271B has a remarkable feature in that a offset adjustment can be performed for every test fixture. Offset adjustments (using the Model 16038A Test Fixture-furnished with instrument) are described in Paragraphs 3-15 through 3-16.

Note

Offset adjustment is done in like manner for other test fixtures. The stray admittance $G_0 + j\omega C_0$ and residual impedance $R_0 + j\omega L_0$ exist on the actual measuring terminals besides the impedance or admittance of DUT. The stray C_0 produces an error in low capacitance and high inductance measurements and also in residual L_0 on low inductance and high capacitance measurements. C and G OFFSET ADJUST compensates for the current flow through C_0 and G_0. L and R OFFSET ADJUST compensates for the voltage drop generated by L_0 and R_0. Offset adjustment must be performed independently at both "Low" test level and at "High" test levels. After adjustment, measurement tolerances are satisfied.

Note

When using the Model 16021A Test Fixture, use the procedure of paragraph 4-10.

3-15. C and G Offset Adjustment.

3-16. Set controls and functions as follows:

FUNCTION ..... C-G
RANGE 1
TEST SIG LEVEL ..... HIGH (LOW)
TRIGGER ..... INT
RATE ..... fully cw
DC BIAS VTG ..... OFF
Unknown ..... Do not connect anything to test fixture.

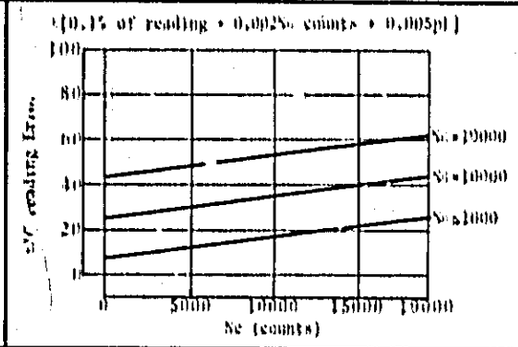
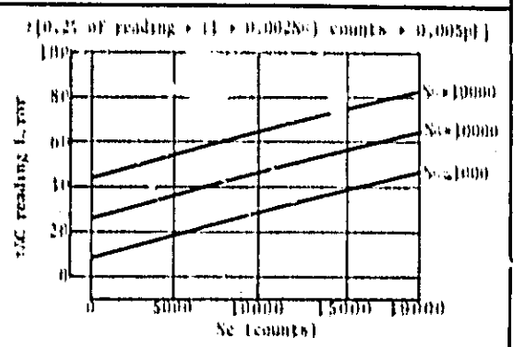
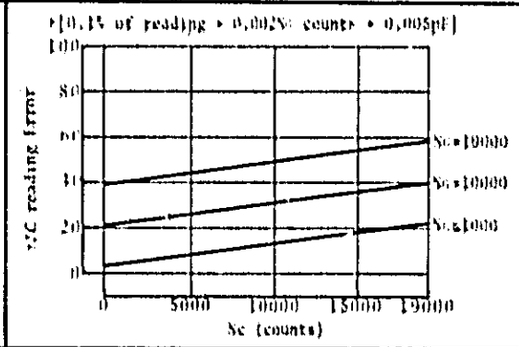
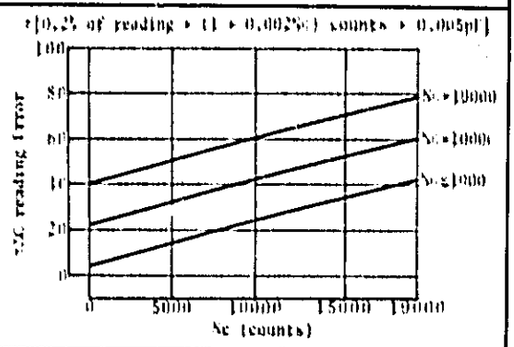
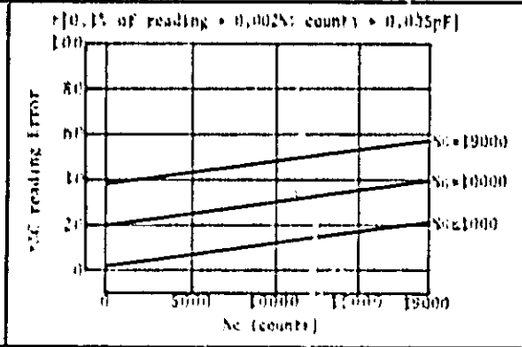
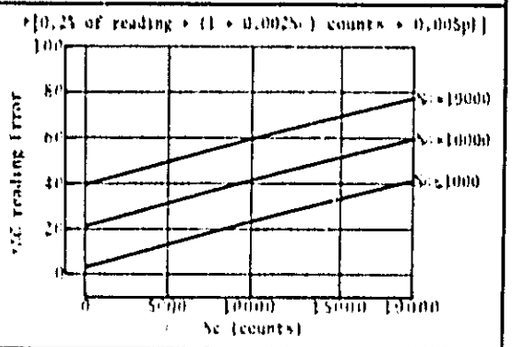
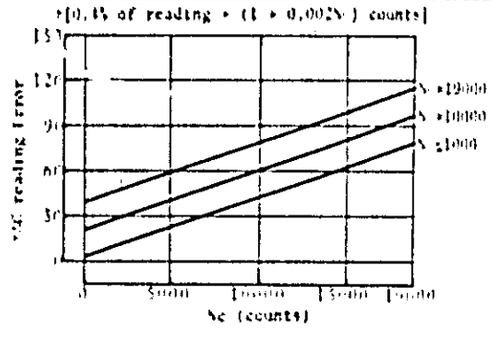
Adjust C or G OFFSET ADJUST controls (front panel) for C (capacitance) and G (conductance) while observing the counter display. Set for zero display.

Note

The adjustment potentiometer for C is 10-turn control and the potentiometer for G is a 3/4-turn control.

Display limits immediately after completing the offset adjustment for C and G are shown in Table 3-1. A offset adjustments when TEST SIG LEVEL is set to LOW level should be done in like manner.

(a) Accuracy of Capacitance Measurement.

RANGE \ TEST SIGNAL LEVEL	HIGH	LOW
1		
2		
3		
4		

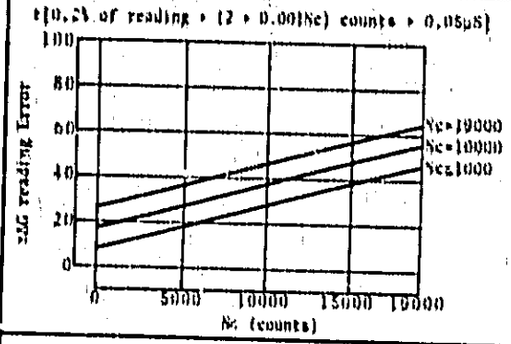
In this Figure:

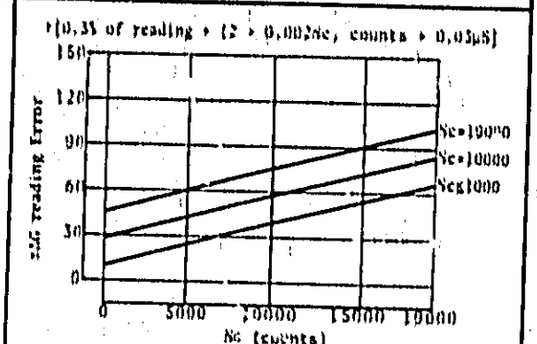
Nc: capacitance readout displayed in counts.
NG: conductance readout displayed in counts.
NL: inductance readout displayed in counts.
NR: resistance readout displayed in counts.
ND: dissipation factor readout displayed in counts.

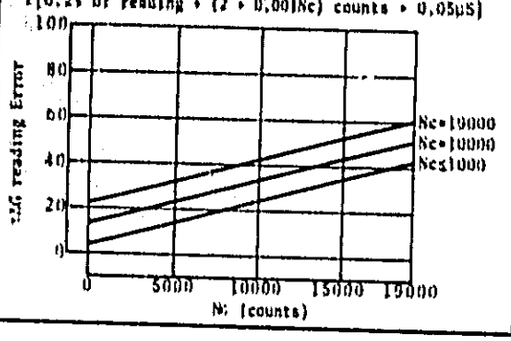
Figure 3-3. Accuracy (Sheet 1 of 6).

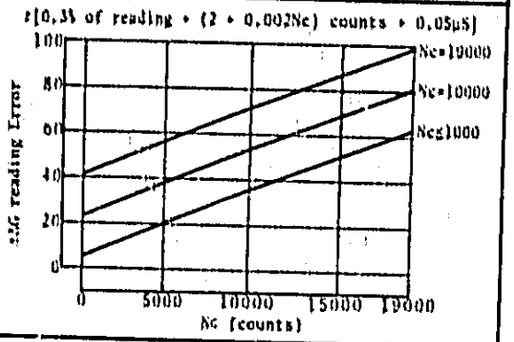
(b) Accuracy of Conductance Measurement,

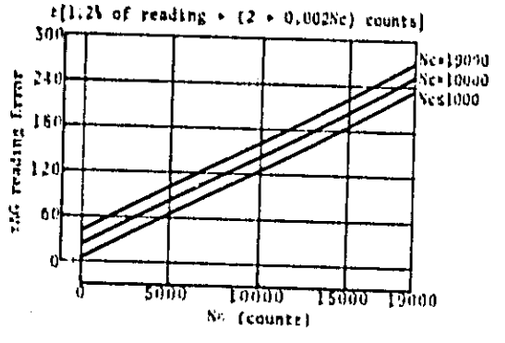
RANGE \ TEST SIGNAL LEVEL	HIGH	LOW
1	±[0.2% of reading + (2 + 0.001Nc) counts + 0.05μS]	±[0.3% of reading + (2 + 0.002Nc) counts + 0.05μS]
2	±[0.2% of reading + (2 + 0.001Nc) counts + 0.05μS]	±[0.3% of reading + (2 + 0.002Nc) counts + 0.05μS]
3		
4	±[1.2% of reading + (2 + 0.002Nc) counts]	











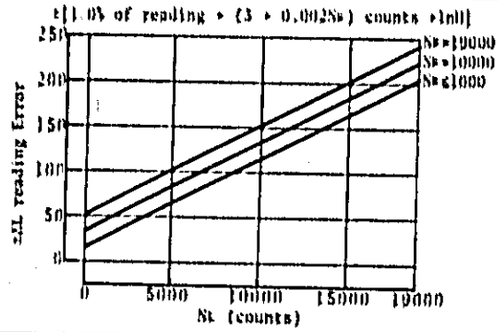
In this Figure:

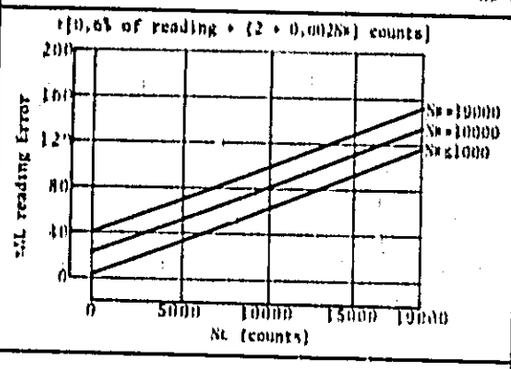
Nc: capacitance readout displayed in counts.
NG: conductance readout displayed in counts.
NL: inductance readout displayed in counts.
NR: resistance readout displayed in counts.
ND: dissipation factor readout displayed in counts.

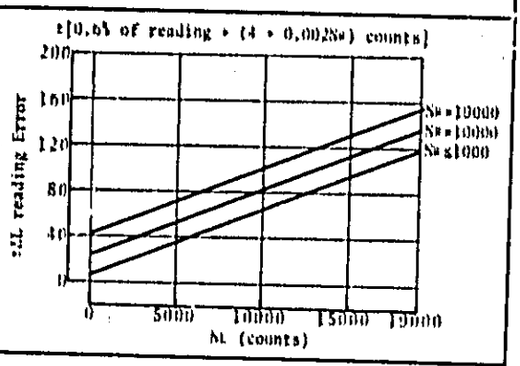
Figure 3-3. Accuracy (Sheet 2 of 6).

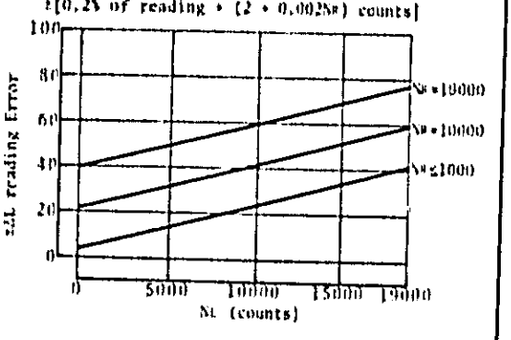
(d) Accuracy of Inductance Measurement.

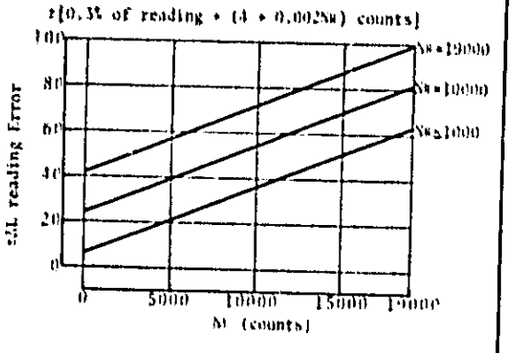
RANGE \ TEST SIGNAL LEVEL	HIGH	LOW
1	±[1.0% of reading + (3 + 0.002Nx) counts +1nH]	
2	±[0.6% of reading + (2 + 0.002Nx) counts]	±[0.6% of reading + (4 + 0.002Nx) counts]
3	±[0.2% of reading + (2 + 0.002Nx) counts]	±[0.3% of reading + (4 + 0.002Nx) counts]
4		









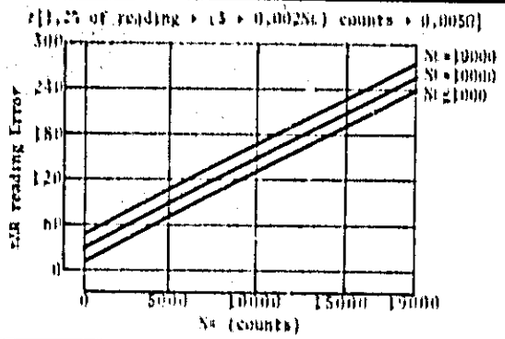
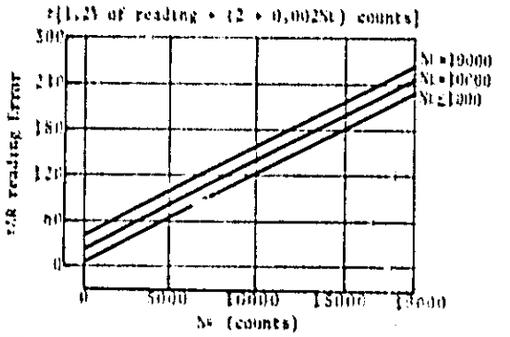
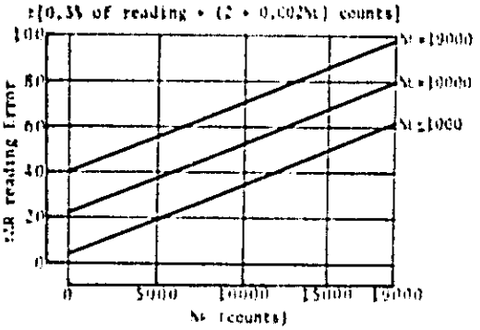
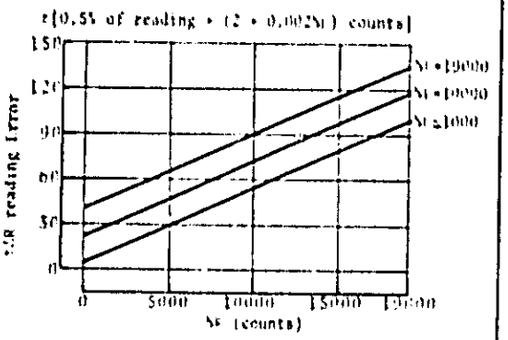


In this Figure:

Nc: capacitance readout displayed in counts.
Nc: conductance readout displayed in counts.
NL: inductance readout displayed in counts.
NR: resistance readout displayed in counts.
ND: dissipation factor readout displayed in counts.

Figure 3-3. Accuracy (Sheet 4 of 6).

(a) Accuracy of Resistance Measurement,

RANGE \ TEST SIGNAL LEVEL	HIGH	LOW
1		
2		
3		
4		

In this Figure:

Nc: capacitance readout displayed in counts.
Nc: conductance readout displayed in counts.
NL: inductance readout displayed in counts.
NR: resistance readout displayed in counts.
ND: dissipation factor readout displayed in counts.

Figure 3-3. Accuracy (Sheet 5 of 6).

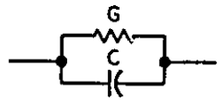
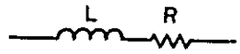
FUNCTION	Measurement Method-Equivalent Circuits
C-G C-D	 $D = \frac{G}{\omega C}$
L-R L-D	 $D = \frac{R}{\omega L}$

Figure 3-4(A). Measurement Method-Equivalent Circuits.

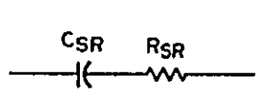
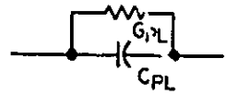
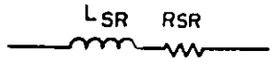
Function	Series Equivalent	Parallel Equivalent
C Measurement		 The 4271B measures this equivalent.
L Measurement	 The 4271B measures this equivalent.	

Figure 3-4(B). Measured Equivalents of DUT (Device Under Test)

3-42. D MEASUREMENT [Refer to Figure 3-4 (B)].

3-43. Capacitor or inductor loss is measured as dissipation factor (D). The measurable part of the dissipation factor is 0.0000 to 1.6000. Dissipation factor (D) measuring methods of the 4271B are explained in detail in Section VIII. For C measurement, dissipation factor (Dc) is presented in the following equation:

$$Dc = \frac{G_{PL}}{\omega C_{PL}} \qquad (3\text{-}1)$$

The value of capacitance (C_{PL}) as measured by the 4271A differs from that of a series capacitance (C_{SR}) equivalent circuit. The conversion equation is given below:

$$C_{SR} = (1 + Dc^2) \cdot C_{PL} \qquad (3\text{-}2)$$

The difference between C_{PL} and C_{SR} is large when Dc is greater than 0.1, but C_{SR} is within 1% of C_{PL} if Dc is 0.1 or less.

For L measurement, the dissipation factor (D_L) of a sample is measured regarding the sample as a series equivalent circuit. D_L is given as follows:

$$D_L = \frac{R_{SR}}{\omega L_{SR}} \qquad (3\text{-}3)$$

Values of inductance, when measured as in a series equivalent circuit (4271B method), differ from that as measured in a parallel equivalent circuit. The conversion equation is as follows:

$$L_{PL} = (1 + D_L^2) \cdot L_{SR} \qquad (3\text{-}4)$$

The relation of eq. (3-4) is the same as that of eq. (3-2). If C_{SR}, C_{PL} and Dc are substituted for L_{PL}, L_{SR} and Dc respectively, eq. (3-4) can be obtained from eq. (3-1).

The dissipation factor (D), when measured by C-G or L-R FUNCTION, can be calculated by equations (3-1) or (3-3). Figure 3-5 is a conversion diagram between G or R and D.

3-44. RANGING.

3-45. MANUAL Ranging.

3-46. The Model 4271B employs three methods of ranging: (1) MANUAL, (2) AUTO, and (3) REMOTE. In this paragraph MANUAL ranging is described. In any range mode, if counted number by C L or G R counter exceeds about 20,000, "OUT OF RANGE" lamp is turned on. At this point, range must be shifted up (if on lower range) or measurement is beyond design range of instrument and may not be performed. The MANUAL range has four positions: 1, 2, 3 and 4. A

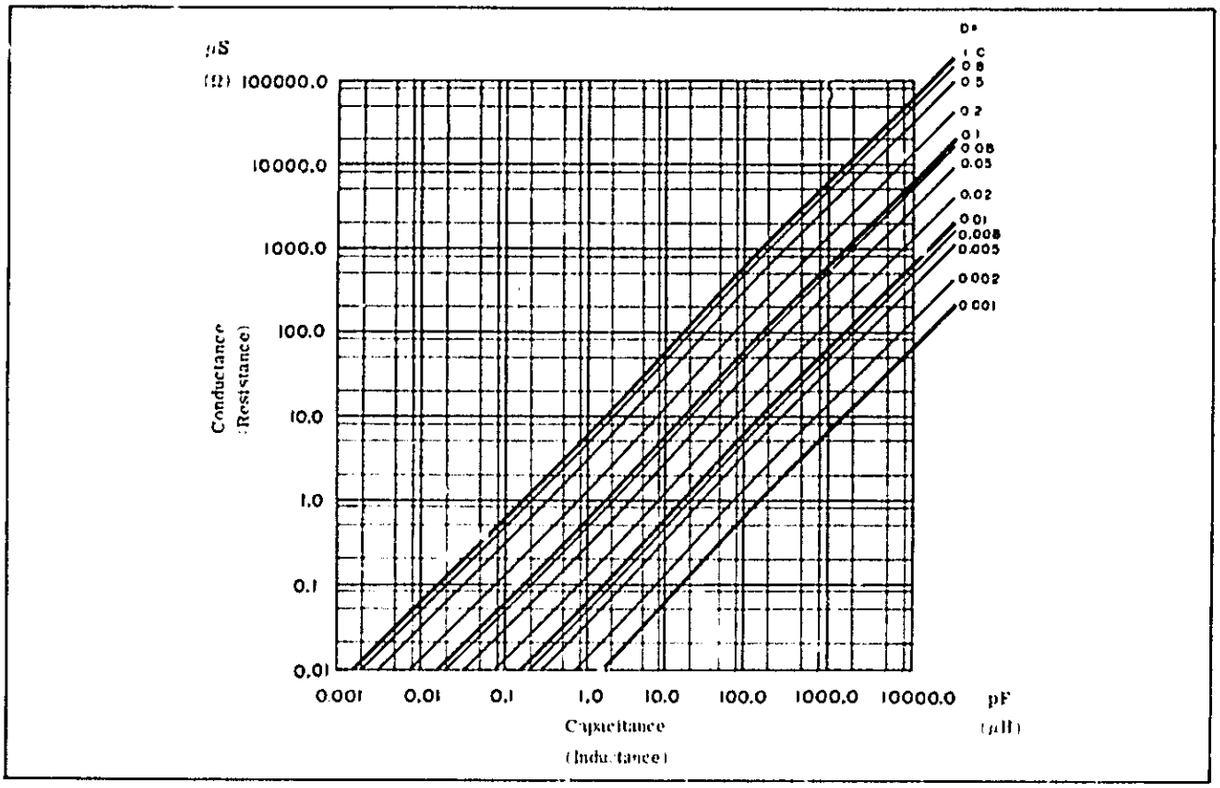


Figure 3-5. Dissipation Factor Conversion Chart.

Table 3-5. Measuring Span.

RANGE	C - G	C - D	RANGE RESISTOR
1	0.000 - 19.000 pF 0.00 - 190.00 μS	0.000 - 19.000 pF .0000 - 1.6000	10 kΩ
2	0.00 - 190.00 pF 0.0 - 1900.0 μS	0.00 - 190.00 pF .0000 - 1.6000	1 kΩ
3	0.0 - 1900.0 pF 0.000 - 19.000 mS	0.0 - 1900.0 pF .0000 - 1.6000	100 Ω
4	0.000 - 19.000 nF 0.00 - 190.00 mS	0.000 - 19.000 nF .0000 - 1.6000	10 Ω

RANGE	L - R	L - D	RANGE RESISTOR
1	0.0 - 1900.0 nH 0.000 - 19.000 Ω	0.0 - 1900.0 nH .0000 - 1.6000	10 Ω
2	0.000 - 19.000 μH 0.00 - 190.00 Ω	0.000 - 19.000 μH .0000 - 1.6000	100 Ω
3	0.00 - 190.00 μH 0.0 - 1900.0 Ω	0.00 - 190.00 μH .0000 - 1.6000	1 kΩ
4	0.0 - 1900.0 μH 0.000 - 19.000 kΩ	0.0 - 1900.0 μH .0000 - 1.6000	10 kΩ

connecting L, C or R unknowns to Model 4271B. The fixture is supplied with inserts for both vertical and axial lead connections. Second set of inserts is stored in fixture housing. Turn fixture over and open door for access. The insert terminals consist of the required 4-terminal pair connections and a shield plate. Cabling includes connections to L_{CUR}, L_{POT}, H_{POT} and H_{CUR} panel connectors. A remote triggering switch bar is connected thru a fifth cable to REMOTE TRIGGER on front panel. A C-G offset adjustment can be made without a DUT (device under test) inserted into terminals. However, when making L-R offset adjustment, insert a small thick copper plate between the terminals (short). The copper plate still will have some very small inductance and resistance which will produce a slight residual error but this is usually negligible.

3-56. Model 16023A DC Bias Controller.

3-57. See Table 1-5. The Model 16023A DC Bias controller is used to control internal bias provided by the instrument when the instrument is equipped with option 001 (Internal DC Bias). The fixture has 3 rotary switches to control bias from 0.0V to 39.9V in 0.1V steps. A remote triggering bar is connected thru the multi-cable connector to furnish remote triggering (panel switch is set to RMT/MAN).

Note

Trigger should always be set to RMT/MAN when using 16023A DC Bias controller. It is possible, if INT trigger is used, that an incorrect voltage may be supplied when Bias control rotary switches are operated.

Note

When Option 101 HP-IB interface is installed, the internal DC bias can only be controlled via HP-IB.

3-58. Model 16032A Test Leads.

3-59. See Table 1-5. Model 16032A Test Leads are used for connecting 4271B to four-terminal device or user-manufactured test fixture which has BNC connectors. An accessory metal terminal shield conductors grounding bracket is furnished with these leads. Operational checks of 4271B can be performed by shorting center conductors of H_{CUR} and H_{POT} terminals and of L_{POT} and L_{CUR} terminals, respectively, for FUNCTION C-G. Shorting center conductors of 4 terminals to each other permits operational check of L-R FUNCTION.

3-60. Model 16033A Test Leads.

3-61. See Table 1-5. Model 16033A Test Leads are user for connecting 4271B unknown terminals to sample to be measured. As small coaxial connectors and slender and flexible coaxial cables are used in the construction of these leads, connecting to device to be measured can easily be done. These leads include an accessory metal terminal shield/connector grounding bracket by which outer conductors of cables are shorted to each other. Operational checks can be performed the same as with Model 16032A.

3-62. Model 16034A Test Fixture.

3-63. See Table 1-5. Model 16034A Test Fixture is provided for chip capacitor measurements. D OFFSET capability provides accurate comparative dissipation factor measurement for comparing with reference chip capacitor.

3-64. Model 16038A Test Fixture.

3-65. See Figure 1-1. Model 16038A Test Fixture is a direct connection type general purpose test fixture and is supplied with 4271B. Two types pairs of inserts (for vertical and axial lead connections) are supplied.

3-66. Model 16039A Test Fixture.

3-67. See Table 1-5. Model 16039A Test Fixture is similar to Model 16038A described in the previous paragraph 3-64. Model 16039A includes D OFFSET capability which provides accurate dissipation factor measurements by comparing D value with reference value.

3-68. DC BIAS.

3-69. Capacitance measurements with DC bias can be made when a bias voltage is supplied in either of two ways:

a. External Bias.

b. Internal Bias (option 001). (See paragraph 3-75).

Note

A bias current option for inductance measurement is not offered.

If external bias is furnished, the standard 4271B can be used to make capacitance measurements with bias. If an internal bias voltage is desired, the instrument should be equipped with option 001 (Internal DC Bias). The following two paragraphs discuss capacitance measurements with external bias.

3-70. External DC Bias.

a. Connect dc voltage source supplying external bias voltage to EXT INPUT (rear panel).

Note

A capacitor should be connected across dc bias voltage supply to lower its impedance at 1MHz. A good quality, film capacitor of about 1 μF is recommended.

b. Set DC BIAS VOLTAGE switch to EXT.

c. If monitoring is required for precise setting of dc bias, connect dc voltmeter to MONITOR (rear panel).

d. Supply dc bias voltage and measure the capacitance.

Note 1

Maximum permissible EXT input dc bias is ±200V.

Note 2

Set the DC BIAS VOLTAGE to OFF except when supplying dc bias voltage. When DC BIAS VOLTAGE is set to OFF, voltage at Hcur terminal is zero.

Note 3

A basic presumption of DC BIAS circuit design (refer to Figure 3-7) is that no dc bias current is drawn by DUT (Device Under Test). If even a very small current is drawn by DUT, actual voltage across DUT and supplied voltage become somewhat different, actual voltage is that measured at MONITOR terminal (series resistance of bias circuit is 470Ω).

3-71. How to Supply More than 200Vdc Bias.

a. External dc bias applied to the DC BIAS VOLTAGE (EXT INPUT) connector on the rear panel is limited to ±200 volts.

b. To use bias voltages greater than 200 volts an external circuit is used. Figure 3-8 shows such a recommended circuit. The bias voltage is limited to maximum working voltages of the unknown capacitor C_X and the blocking capacitors C_1 and C_2

CAUTION

EXTERNAL BIAS VOLTAGE GREATER THAN 300 VOLTS CAN BE NEVER APPLIED USING CIRCUIT SHOWN IN FIGURE 3-8. A SPECIAL PROTECTION CIRCUIT MUST BE ADDED WHEN BIAS VOLTAGE IS GREATER THAN 300 VOLTS.

CAUTION

DC BIAS VTG SWITCH ON REAR PANEL MUST BE IN OFF POSITION.

c. To monitor the voltage another filter section consisting of L_1', R_1', R_2' and C_3' is added as shown in Figure 3-8 for connection voltmeter.

CAUTION

USE EXTREME CAUTION WHEN WORKING WITH CHARGED CAPACITORS, FLOATING OR UNGROUNDED CIRCUITLY.

3-72. Method of Applying a DC Bias Current to an Inductor.

a. The bias current superposed in an inductor being measured with the 4271B must not flow into the instrument.

b. Figure 3-9 shows a recommended circuit for inductor current biasing, measuring requirements and suggested procedures.

CAUTION

DC BIAS VTG SWITCH ON REAR PANEL MUST BE IN OFF POSITION.

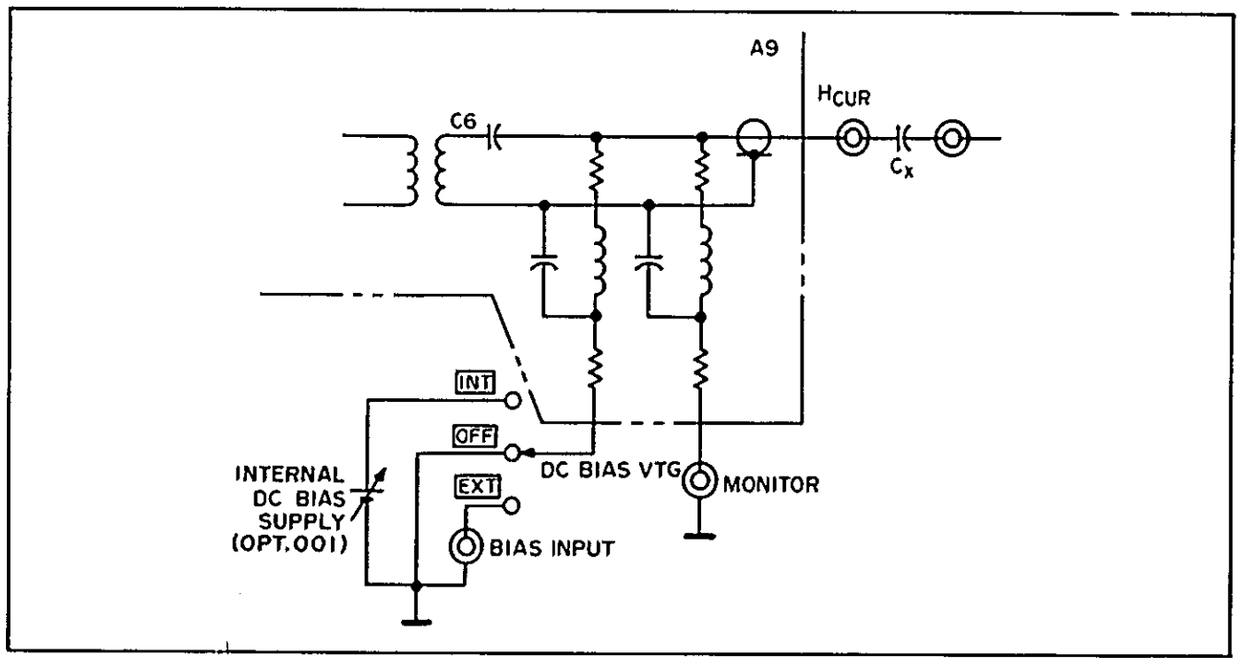
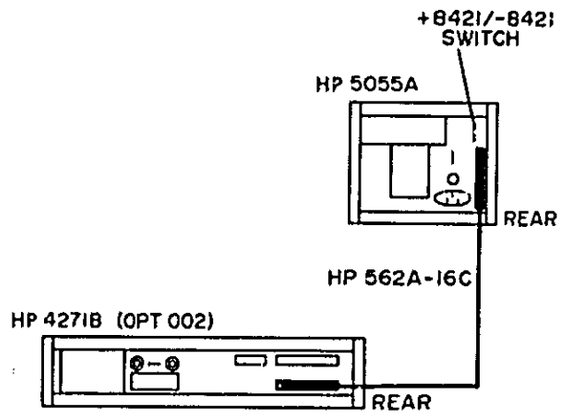
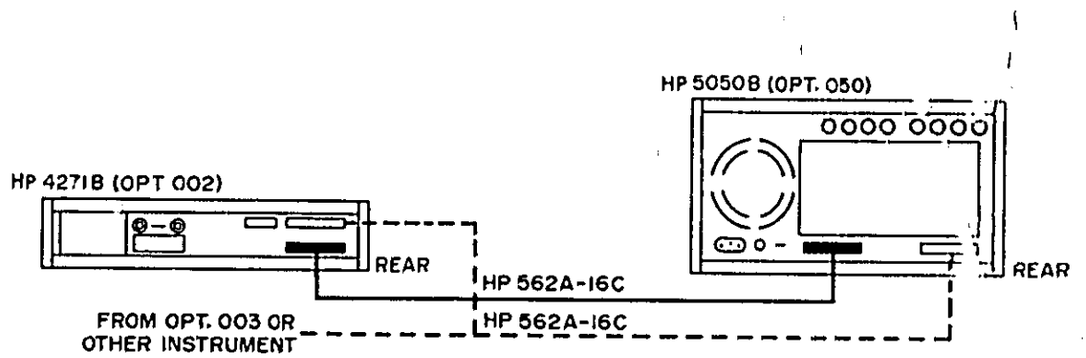


Figure 3-7. Bias Circuit.

(1) Model 4271B Opt.002 and Model 5055A Recorder.
Note: Set +8421/-8421 switch (rear of 5055A) to +8421.



(2) Model 4271B Opt.002 (and 003) and Model 5050B Opt.050 Recorder.



(3) Model 4271B Opt.002 and Model 5050B Opt.051.

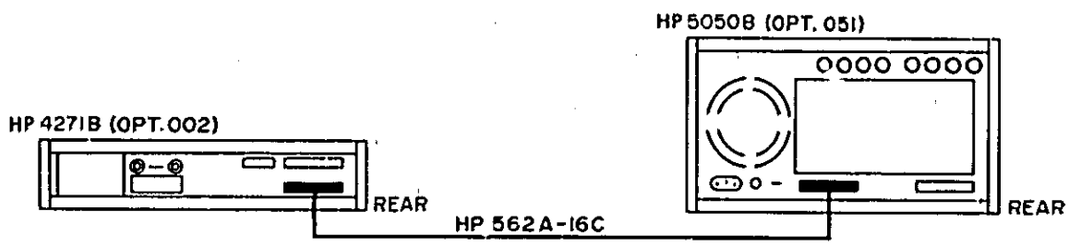


Figure 3-11. C/I. CD Output (OPT. 002).

Table 3-6. Data Format (OPT. 002).

Column				
8	7	6	5	4, 3, 2, 1
Unit	Magnification of Data	Warning Signal	Data or Symbol	C/L Data

Unit (column 8)

4271B Display	Connector Pin				Printed letter
	15	16	40	41	
pF	H	L	L	L	1
nF	H	H	L	L	3
nH	H	L	H	L	5
μH	H	H	H	L	7

Warning Signal (Column 6)

4271B Display	Connector Pin				Printed letter
	11	12	36	37	
"OUT OF RANGE" or "UNBAL"	L	L	H	H	V
Blank	H	H	H	H	*

Magnification of Data (Column 7)

4271B Display	Connector Pin				Printed letter
	13	14	38	39	
000.0 (10^{-1})	H	L	L	L	1
00.00 (10^{-2})	L	H	L	L	2
0.000 (10^{-3})	H	H	L	L	3

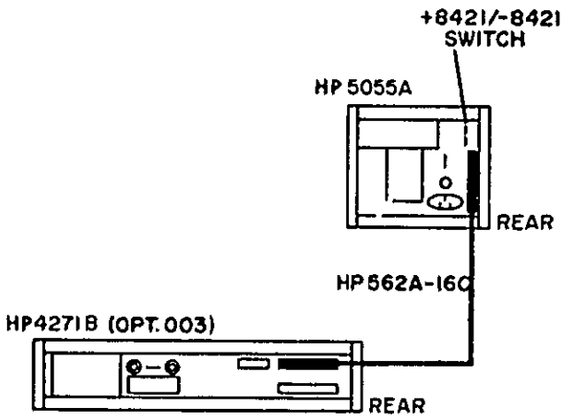
Data or Symbol (Column 5)

4271B Display	Connector Pin				Printed letter
	9	10	34	35	
1	H	L	L	L	1
-	H	H	L	H	-
Blank	H	H	H	H	*

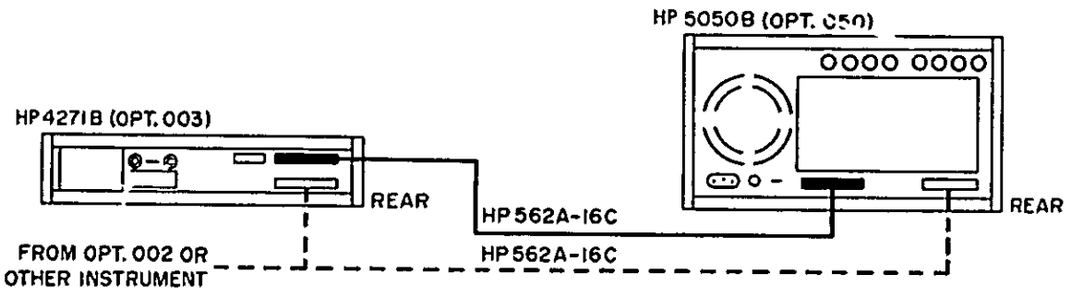
Data (Column 1 - 4)

HP 4271B Display	BCD				Printed letter
	1	2	4	8	
0	L	L	L	L	0
1	H	L	L	L	1
2	L	H	L	L	2
3	H	H	L	L	3
4	L	L	H	L	4
5	H	L	H	L	5
6	L	H	H	L	6
7	H	H	H	L	7
8	L	L	L	H	8
9	H	L	L	H	9

(1) Model 4271B Opt.003 and Model 5055A Recorder.
Note: Set +8421/-8421 Switch (rear of 5055A) to +8421.



(2) Model 4271B Opt.003 and Model 5050B Opt.050.



(3) Model 4271B Opt.003 and Model 5050B Opt.051.

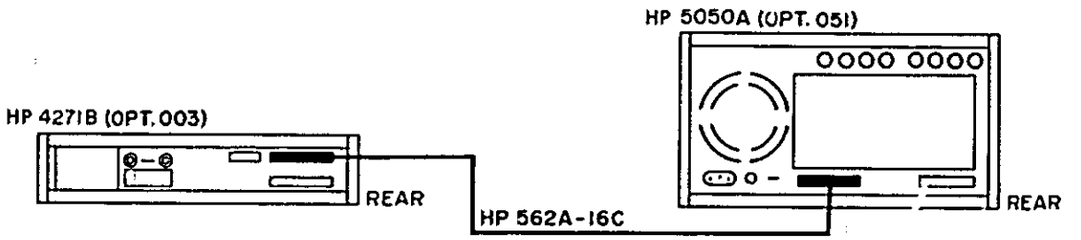


Figure 3-14. G/R/D BCD Output (OPT. 003).

Table 3-7. Data Format (OPT. 003).

Column				
8	7	6	5	4, 3, 2, 1
Unit	Magnification of Data	Warning Signal	Data or Symbol	G/R/D Data

Unit (Column 8)

4271B Display	Connector Pin				Printed letter
	15	16	40	41	
D	L	L	L	L	0
μS	L	H	L	L	2
mS	L	L	H	L	4
Ω	L	H	H	L	6
kΩ	L	L	L	H	8

Warning Signal (Column 6)

4271B Display	Connector Pin				Printed letter
	11	12	36	37	
"OUT OF RANGE" or "UNBAL"	L	L	H	H	V
D → GR	H	L	H	H	A
Blank	H	H	H	H	*

Magnification of Data (Column 7)

4271B Display	Connector Pin				Printed letter
	13	14	38	39	
000.0 (10^{-1})	H	L	L	L	1
00.00 (10^{-2})	L	H	L	L	2
0.000 (10^{-3})	H	H	L	L	3
.0000 (10^{-4})	L	L	H	L	4

Data or Symbol (Column 5)

4271B Display	Connector Pin				Printed letter
	9	10	34	35	
1	H	L	L	L	1
-	H	H	L	H	-
Blank	H	H	H	H	*

Data (Column 1 - 4)

HP 4271B Display	BCD				Printed letter
	1	2	4	8	
0	L	L	L	L	0
1	H	L	L	L	1
2	L	H	L	L	2
3	H	H	L	L	3
4	L	L	H	L	4
5	H	L	H	L	5
6	L	H	H	L	6
7	H	H	H	L	7
8	L	L	L	H	8
9	H	L	L	H	9

3-83. OPTION 101 HP-IB INTERFACE.

3-84. The Model 4271B Opt 101 is remotely controlled by means of the Hewlett-Packard Interface Bus (HP-IB) which is a carefully defined instrumentation interfacing method that simplifies the integration of instruments, calculators, and computers into systems.

Note

HP-IB is Hewlett-Packard's implementation of IEEE Std. 488-1975 Standard Digital Interface for Programmable Instrumentation.

3-85. Connection to HP-IB.

3-86. The 4271B may be connected into an HP-IB bus configuration with or without a controller (e.g. without a calculator). In an HP-IB system without a controller, the 4271B Option 101 is able to talk only (see paragraph 3-96). These two configurations are illustrated in Figure 3-19 Model 4271B Connected to the HP-IB.

3-87. Interface Connector.

3-88. Message arrangement by pin number for A34 J4, the HP-IB bus connector, with a description of each line is given in Figure 3-20.

3-89. All communications between the 4271B and the controller (and/or other instruments on the bus) are channelled through the interface connector A34 J4. This includes both interface messages to and from the 4271B and data outputted by the instrument.

Note

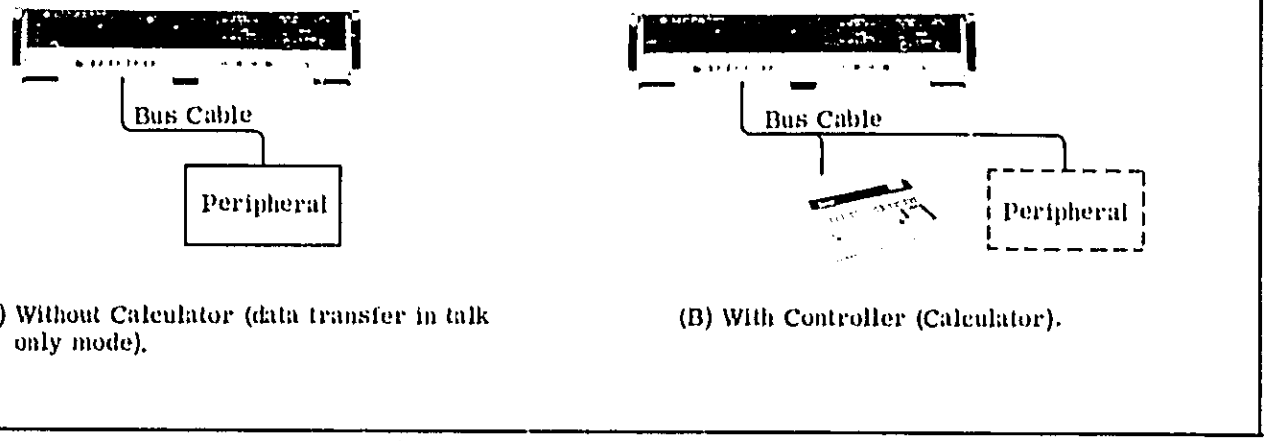
The maximum cumulative length of HP-IB cabling in the system must not exceed 2 meters of cable per device (up to 15 devices) or 20 meters, whichever is less.

3-90. Features.

3-91. The front panel of a Model 4271B equipped with Option 101 HP-IB Interface (see Figure 3-22) is the same as that of a standard instrument. Figure 3-23 shows the rear panel of a 4271B with Option 101 installed. Figure 3-22, the front panel, is shown for reference.

3-92. The Address.

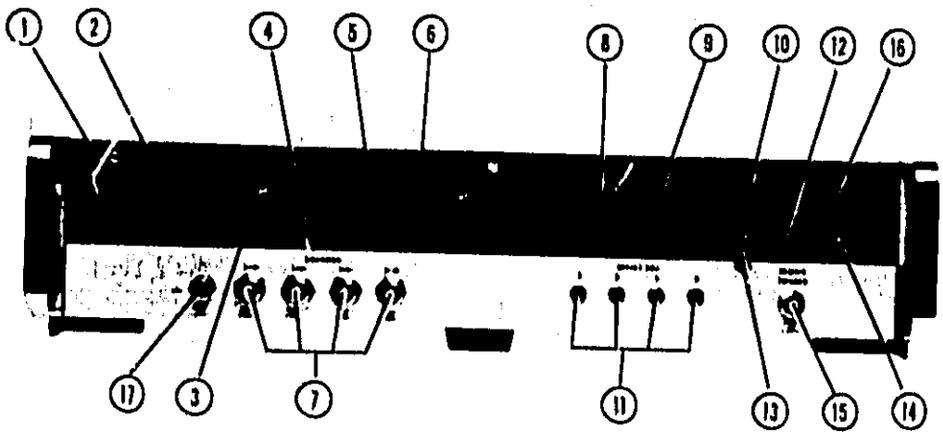
3-93. Each device on the bus including the controller (if used) must be provided with an identity to distinguish it from other devices on the bus. The controller (calculator or computer), in following its program, uses these addressed to select which units should perform as talkers and whichas listeners.



(A) Without Calculator (data transfer in talk only mode).

(B) With Controller (Calculator).

Figure 3-19. Model 4271B Connected to HP-IB.



1. Measuring Rate Lamp. Lights during measuring. During hold time lamp is extinguished.

2. C/L Display. Capacitance or inductance display with decimal point and unit. If this display shows "-200", C/L and G/R/D displays have no meaning.

3. OUT OF RANGE Lamp. Lights when either C/L or G/R/D or both exceed the specified maximums. When this lamp lights, display indication has no meaning.

4. UNBAL Lamp. Lights when the bridge section is not balanced. When this lamp lights, the display indication has no meaning.

5. D → G, R Lamp. Lights when the C-D or L-D mode selected and display of C or L is less than approximately 1000. When this lamp lights, set FUNCTION switch to C-G or L-R.

6. G/R/D Display. Conductance, resistance or dissipation factor display with decimal point and unit. If this display shows "-200", C/L and G/R/D displays have no meaning.

7. Unknown Terminal. Provides connections for 4-terminal pair. Instrumen. does not function properly unless test leads are connected to these terminals.

8. FUNCTION. Selects measurement functions:

   C-D: Capacitance & Dissipation Factor.
   C-G: Capacitance & Conductance.
   L-R: Inductance & Resistance.
   L-D: Inductance & Dissipation Factor.
   RMT: Remote Control (Optional).

9. RANGE. Selects measurement ranges:

   RMT: Remote Control (Optional).
   AUTO: Automatic Range Selection.
   MANUAL: 1, 2, 3 or 4.

10. TEST SIG LEVEL.

    C measuring mode: Selects test signal level, HIGH (500mV) and LOW (20mV). On range 4, test signal level is limited to 20mV.
    L measuring mode: Selects test signal level, HIGH (50μA to 5mA) and LOW (2μA to 2mA). On range 1, test signal level is limited to 2mA.

Figure 3-1. Front and Rear Panels (sheet 1 of 2).

manual range is selected by positioning slide switch on front panel to match value of unknown. Table 3-5 shows measuring span for each RANGE and FUNCTION and selected range resistor.

3-47. AUTO and REMOTE Ranging.

a. Auto ranging. In AUTO mode setting of RANGE switch, a range appropriate for measuring the value of sample is automatically selected by an Auto Range Control Circuit in the 4271B. Range selected by Auto ranging is determined by larger part of imaginary part (C, L) and the real part (G/L) of measured sample. For example, if in C-G FUNCTION capacitance displayed is 100.00pF and conductance is 1700.0 μS, selected range is determined by value of G (17000counts). Auto ranging control is accomplished as follows: If counted number of both C/L and G/R counters is between 1600 and 18000 counts, an optimum range has been selected and actual range will be determined by the higher count. If counted number is greater than 18000 (either C, L or G/R counter) the range is shifted up (for example, from 3 to 4). And, in like manner, if less than 1600, range is shifted down (for example, from 3 to 2).

b. Remote ranging. REMOTE ranging is used for external range control by (for example) OPT. 101 HP-IB Interface. The RANGE switch on front panel is set to RMT position.

3-48. MEASURING RATE.

3-49. Measuring rate is decided by setting of RATE control. Clockwise rotation results in a higher rate and counterclockwise rotation produces a lower rate. The RATE control is functional only when TRIGGER mode is set to INT position. If TRIGGER mode is set to RMT/MAN position, internal rate setting by RATE control is disabled. When TRIGGER is set to RMT/MAN, a measurement can be taken and measured value displayed by depressing and releasing Manual Trigger button. If an external trigger source is connected to REMOTE TRIGGER terminal, measurements at an arbitrary measuring rate can be performed.

Note

When 4271B is externally triggered with pulse generator, period of pulses should be set to longer than measuring time. Figure 3-6 shows that measuring time of 4271B is time interval between generation of reset pulse and end pulse.

3-50. TEST FIXTURES.

3-51. Eight (8) types of test fixtures are available for use with the Model 4271B 1MHz Digital LCR Meter. The following paragraphs explain the purpose of each fixture and give a brief description.

3-52. Model 16021A Test Fixture.

3-53. The Model 16021A Test Fixture is illustrated in Table 1-5. The purpose of this fixture is to calibrate the Model 4271B with a standard capacitor or a standard resistor. Full procedure is outlined in Section IV. A type GR 900-WN short Circuit Termination (0Ω) is used when making offset adjustment for L and R. The fixture includes cables for LCUR, LPOT, HPOT and HCUR unknown connections to panel connectors. The unknown is connected to fixture through type GR-900 Connector. A remote triggering switch at fixture is connected through a cable to REMOTE TRIGGER BNC on front panel.

3-54. Model 16022A Test Fixture.

3-55. The Model 16022A Test Fixture is illustrated in Table 1-5. This is a general purpose fixture for

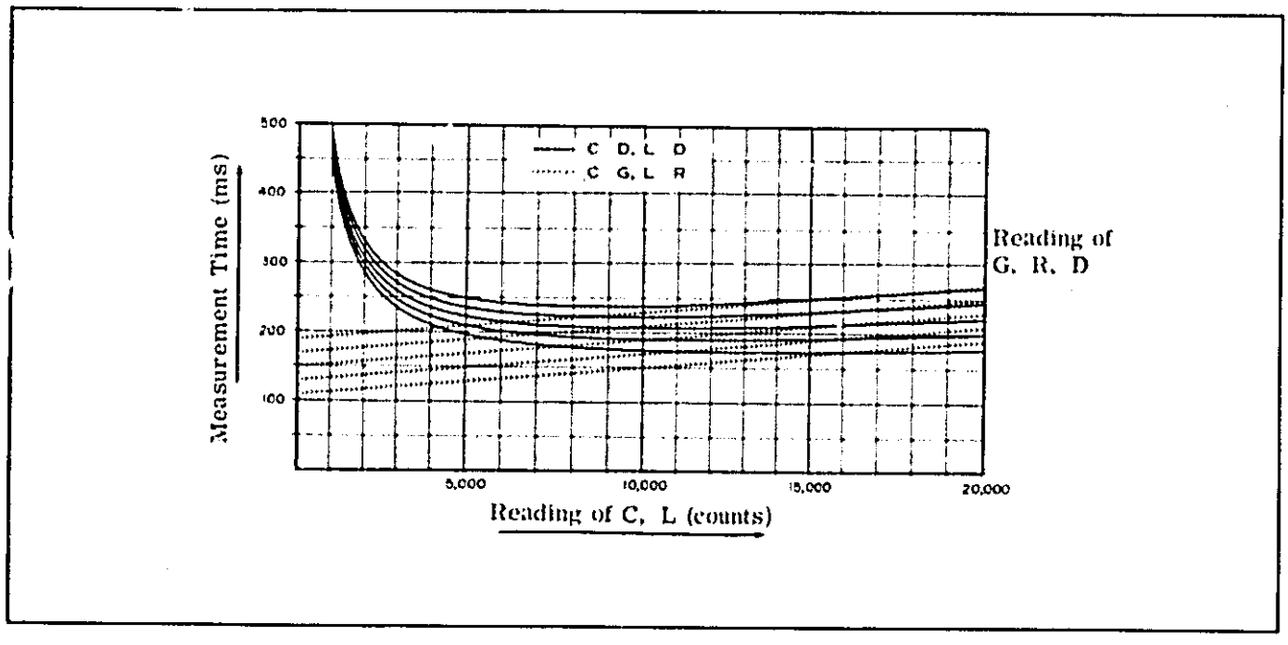


Figure 3-6. Measuring Time.

Table 3-1. C and G Display Limits Immediately after Offset Adjustment.

FUNCTION	RANGE	LEFT SIDE DISPLAY	RIGHT SIDE DISPLAY
C - G	AUTO	0 ± 1 (1) count	0 ± 1 (1) count
	1	0 ± 1 (1) count	0 ± 1 (1) count
	2	0 ± 3 (4) counts	0 ± 4 (5) counts
	3	0 ± 2 (3) counts	0 ± 4 (4) counts
	4	0 ± 3 (3) counts	0 ± 4 (4) counts

( ) is at LOW level.

3-17. L and R Offset Adjustment.

3-18. Set controls and functions as follows:

FUNCTION ..... L-R
RANGE 1
TEST SIG LEVEL ..... HIGH (LOW)
TRIGGER ..... INT
RATE ..... Fully cw
DC BIAS VTG ..... OFF
Unknown ..... Short test fixture.

The offset adjustment for L (Inductance) and R (Resistance) is done while observing counter displays.

Note

The potentiometer for L is a 10-turn pot. The potentiometer for R is a 3/4 turn control.

The display limits immediately after completing offset adjustments are shown in Table 3-2. A offset adjustment when TEST SIG LEVEL is set to LOW level should be done in like manner.

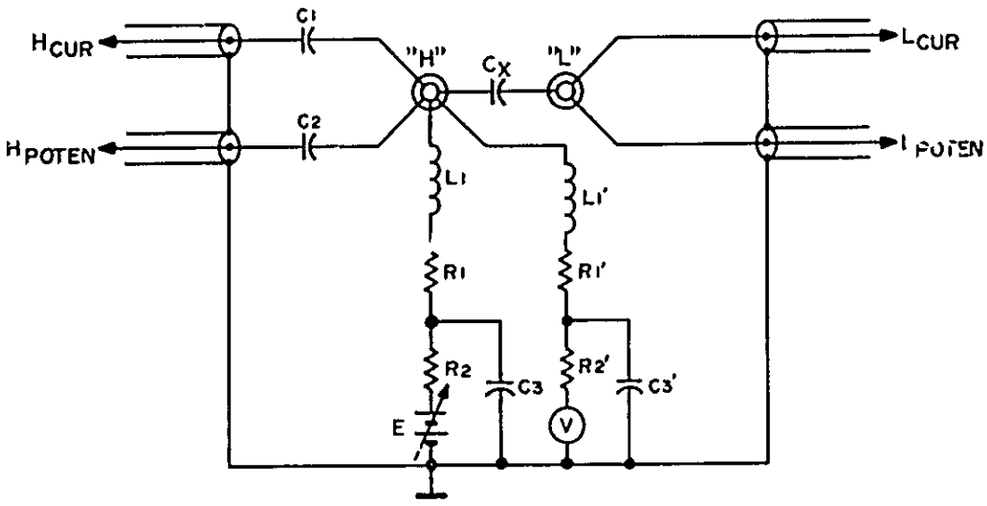
3-19. DISPLAY.

3-20. Counter displays show value of sample when being measured (after zero adjustments). Simultaneously the decimal point, unit and polarity (only minus is displayed) may be read. The counter is full 4-digit plus overrange of 100%. The display may read from approximately -100 to the maximum value of 19999. When display is less than approximately -100, the display instantaneously changes to -200 (and never becomes less than -200). When "UNBAL" lamp is lit, the measured value displayed on front panel is ambiguous as a measured value. When "OUT OF RANGE" lamp is lit, both C/L & G/R/D displays have no meaning. The "D→G, R" lamp lights when measured value of C or L becomes less than about 1000 (FUNCTION set to C-D or L-D). If "D→G, R" is lit, measured value of D has no meaning. C/L display becomes measured value when C/L and G/R displays do not show 0000. When "D→G, R" is lit, FUNCTION should be changed to C-G or L-R. Normally 0 display to left of decimal point has no meaning and is blanked. When C/L display shows a negative value of more than -100 [e.g. -48pF (or -48 μH)] it means DUT is inductive (or capacitive).

Table 3-2. L and R Display Limits Immediately after Offset Adjustment.

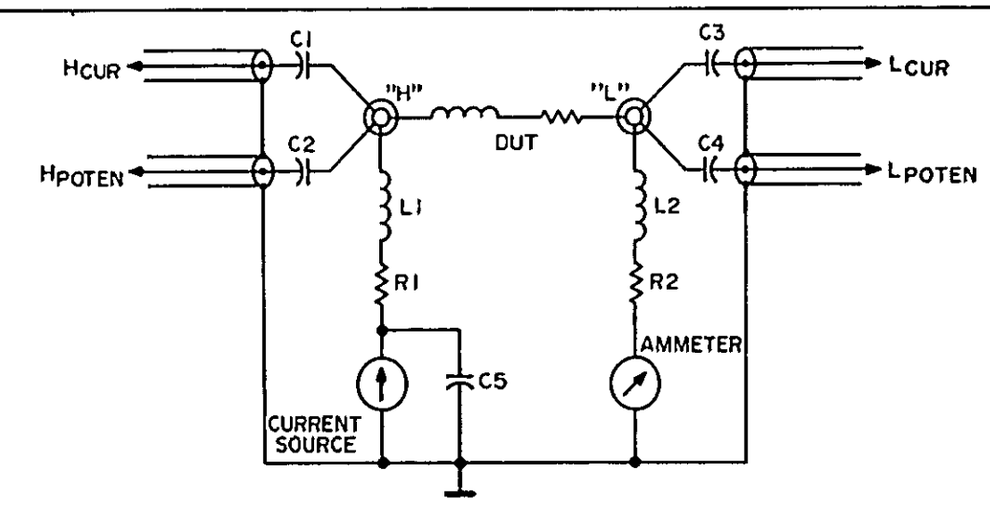
FUNCTION	RANGE	LEFT SIDE DISPLAY	RIGHT SIDE DISPLAY
L - R	AUTO	0 ± 1 (1) count	0 ± 1 (1) count
	1	0 ± 1 (1) count	0 ± 1 (1) count
	2	0 ± 4 (6) counts	0 ± 4 (4) counts
	3	0 ± 4 (6) counts	0 ± 4 (4) counts
	4	0 ± 4 (6) counts	0 ± 4 (4) counts

( ) is at LOW level.



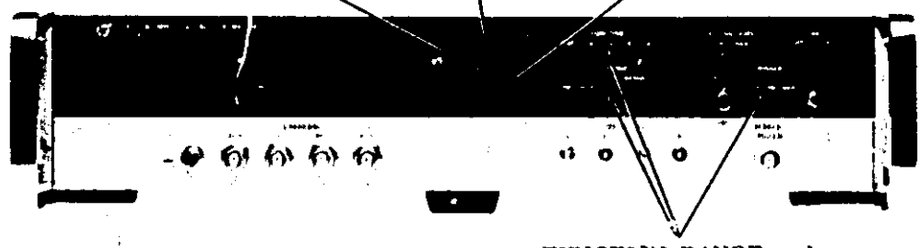
CKT Symbol	Parts Required Specifications
C_1, C_2, C_3, C_3'	$\geq 0.2\mu F$, Working VTG is greater than EXT Bias Voltage.
L_1, L_1'	$\approx$1mH
R_1, R_2, R_1', R_2'	$\geq$1kΩ

Figure 3-8. External Bias Circuit (E ≤ 300V).



CKT Symbol	Parts Required Specifications
C_1, C_2, C_3, C_4, C_5	$\geq 0.2\mu F$
L_1, L_2	$\approx$1mH
R_1, R_2	$\approx$1kΩ

Figure 3-9. DC Current Bias Circuit for Inductors.



Note: Refer to Figure 3-1 in 4271B Operating and Service manual for full front panel description.

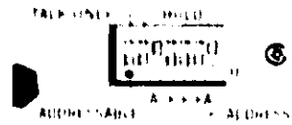
Note: Mechanically the front panel of a 4271B equipped with HP-IB Option 101 is the same as that of a standard 4271B.

Figure 3-22. Front Panel HP-IB Features.

switch in the group of control switches on the rear panel is set its HOLD (1) position (see Figure 3-23).

Note

Setting the HOLD switch to its "1" position (no relation to internal circuitry) disables the internal trigger of the 4271B so that the peripheral instrument (e. g. printer) can assume control of trigger and trigger timing. This permits the peripheral to trigger the 4271B Opt 101, to exchange handshake messages, and to accept measured data from the 427'.s. If a controller (calculator) is connected to the bus, the control switch must be returned to its ADDRESSABLE position.



Switches set for a bit pattern of 10001 (decimal code 17, an ASCII listen address of 1 and a talk address of Q (see paragraph 3-94).

1	0	0	0	1
A5	A4	A3	A2	A1

The TALK ONLY-ADDRESSABLE switch is set to ADDRESSABLE (see paragraph 3-96), the HOLD switch is set to its non-HOLD position (see paragraph 3-96). Refer to Table 3-9 for other address settings.

Figure 3-23. Control of Switch.

3-21. ACCURACY.

3-22. The measuring accuracy of the Model 4271B 1MHz Digital LCR Meter is given in Table 1-1, Specifications. Measuring accuracy varies with value of unknown sample being measured and level of test signal (HIGH or LOW). Moreover, accuracy of capacitance changes with value of conductance of measured sample, accuracy of inductance with value of resistance, accuracy of conductance with value of capacitance and accuracy of resistance with the value of inductance, respectively. Each accuracy has a digital error of ±1 count. Derivation equation and accuracy diagram is given and shown in Figure 3-3. Accuracy does not vary when dc bias voltage is applied or a dc bias current applied to unknown sample.

3-23. ANNUNCIATORS.

3-24. "UNBAL" Lamp.

3-25. "UNBAL" lamp is an indicator which shows that bridge is unbalanced. This lamp is turned on and off when the FUNCTION and RANGE are not appropriate for sample being measured, or if value of the sample varies during balancing operation, or if bridge section of 4271B is faulty and in certain other situations. "UNBAL" lamp is turned on and off at same rate as measuring rate lamp. When "UNBAL" lamp is turning on and off, the counter display has no meaning as a measured value.

3-26. "OUT OF RANGE" Lamp.

3-27. "OUT OF RANGE" lamp lights when the total of C/L or G/R/D display is beyond about 20,000 counts. If "OUT OF RANGE" lamp is lit, RANGE should be switched to higher range.

3-28. "D→G, R" Lamp.

3-29. "D→G, R" lamp is turned on when count of C/L counter is less than 1000 (approximately) and FUNCTION is set to C-D or L-D. When "D→G, R" lamp lights it means that FUNCTION C-D should be set to C-G and L-D to L-R.

3-30. OPERATIONAL CHECK.

3-31. An operational check of the Model 4271B may be done with its front panel controls as outlined and discussed in the following paragraphs.

3-32. Measuring Rate Lamp.

3-33. The on-off period of lamp is generally determined by setting of RATE control, but its period is also slightly affected by FUNCTION setting and value of sample. The on-off period of the measuring rate lamp for RATE control mid-range and extreme settings as follows:

Table 3-3. Measuring Rate.

RATE setting	Period
Fully cw.	Approximately .2 sec.
Centered.	Approximately 1 sec.
Fully ccw.	Approximately 3 sec.

Note

On and off switching continues and is visible even if RATE is set to full cw.

Turn "ON" time interval is approximately 100msec to 300msec and is slightly varied by FUNCTION setting and value of sample. When TRIGGER mode switch is set to RMT/MAN position, measuring rate lamp is turned on (once only) when manual trigger button is depressed and released. Measured value is then displayed and held. Unless manual trigger button is again depressed and released, the measuring rate lamp does not light and a measurement is not taken.

3-34. Decimal Point/Unit Display.

3-35. The decimal points and units of display are checked by FUNCTION and RANGE settings as shown in Table 3-4. Other controls positions are arbitrary. No sample may be connected for this test.

Table 3-4. Decimal Points and Units.

FUNCTION	RANGE	LEFT SIDE DISPLAY	RIGHT SIDE DISPLAY
C - D	1	0.000 pF	.0000 D
	2	00.00 pF	
	3	000.0 pF	
	4	0.000 nF	
C - G	1	0.000 pF	00.00 μS
	2	00.00 pF	000.0 μS
	3	000.0 pF	0.000 mS
	4	0.000 nF	00.00 mS
L - R	1	000.0 nH	0.000 Ω
	2	0.000 μH	00.00 Ω
	3	00.00 μH	000.0 Ω
	4	000.0 μH	0.000 kΩ

3-73. OPTION OPERATION.

3-74. Operating instructions for Option 001, 002, 003, 004 and 101 are described in the following paragraphs.

3-75. OPTION 001 INTERNAL DC BIAS.

3-76. Internal DC Bias is possible by equipping 4271B with option 001 which adds A21 board to instrument. The main applications feature gained by dc bias option is the additional capability of instrument to measure characteristics of variable capacitance diodes. A user designed or HP Model 16023A DC Bias Controller is required when making dc bias measurements (see paragraph 3-56). Bias voltage is applied to capacitor being measured. When bias is switched at the 16023A, internal bias controls apply voltage at new setting to next measurement. If bias voltage is changed during a measurement, application of the bias is delayed until beginning of next measurement cycle.

3-77. Use of Internal Bias.

a. Connect a bias controller such is Model 16023A or equivalent user designed controller to DC BIAS CONTROL on rear panel.

Note

Refer to Figure 3-10 Model 16023A Connector details. All data (including trigger signal) through control connector are transfered to 4271B is ground true mode. See also paragraph 3-56 for other 16023A information.

Note

The 16023A fixture can not be used with Option 101 HP-IB Interface.

b. Set DC BIAS VTG switch (on rear panel) to INT.

c. Set TRIGGER switch to RMT/MAN. In RMT/MAN initiation of a measurement cycle is triggered either from an external signal or by pushing trigger button (manually) Display is held between triggers.

Note

When Option 101 HP-IB interface is installed, the internal DC bias can only be controlled via HP-IB (see paragraph 3-132).

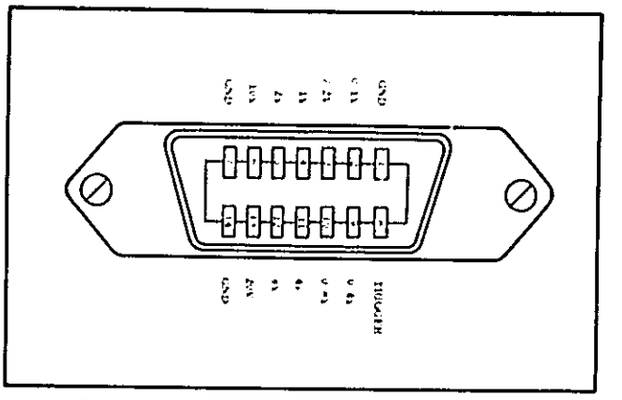


Figure 3-10. Bias Voltage Control Jack.

3-78. DATA RECORDING.

3-79. When a Model 4271B is equipped with option 002 (C/L BCD Output), option 003 (G/R/D BCD Output), option 004 (Parameter Serial BCD Output), all data (depending upon option selected) measured by the instrument becomes available at rear panel connectors for recording. The following paragraphs provide more detailed information on recording options. Description and theory for each option is presented in Section VIII.

3-80. Option 002 C L BCD Output.

a. HP recorders Model 5055A and Model 5050B-OPT. 050, OPT. 051 may be connected to a Model 4271B equipped with option 002. All measured data can be recorded including data taken under biased conditions (except recording of the bias voltage itself).

b. Refer to Figure 3-11 for typical recording connection configurations. As shown in (1) and (3) of the figure, recording is limited to that supplied by option 002 of the 4271B. In (2), option 003 can be added to 4271B to record additional data. Then the 5050B OPT. 050 recorder can record the information carried from DATA OUTPUT connector as well as that from C, L DATA OUTPUT connector.

c. Data formats are given in Table 3-6.

d. Pin connections for option 002 and recorder are shown in Figure 3-12.

e. Figure 3-13 is a timing diagram for option 002 and recorder.

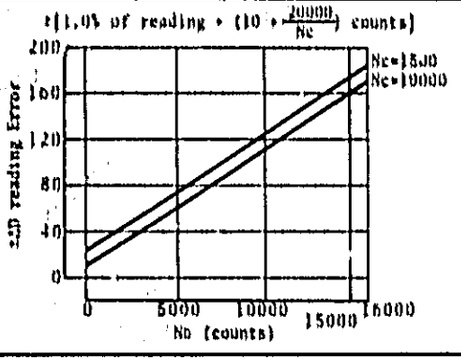
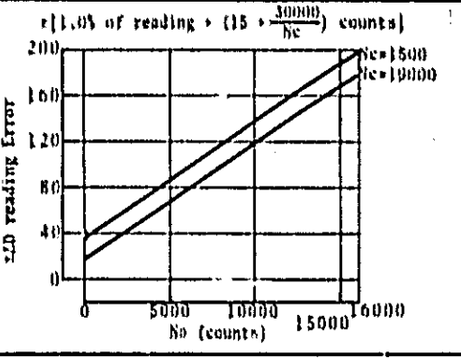
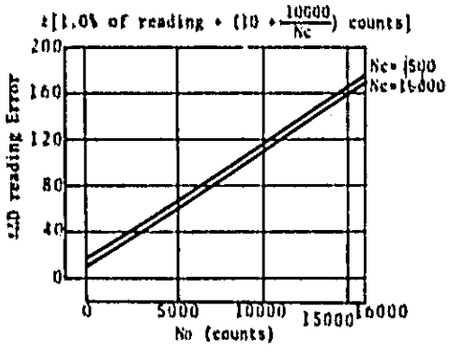
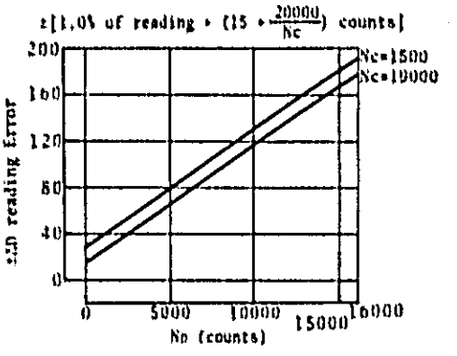
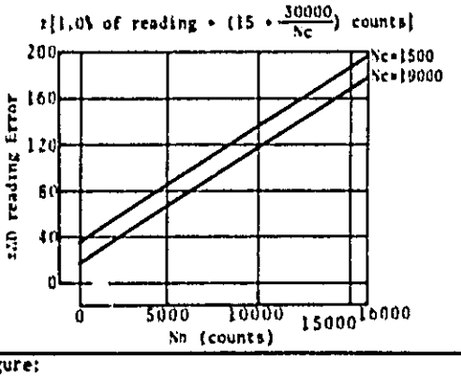
Table 3-9. Address Codes.

ASCII Code Character		Binary Code							Octal Code		5 BIT DECIMAL
Listen Address	Talk Address	b7	b6	A5 b5	A4 b4	A3 b3	A2 b2	A1 b1	Listen	Talk	
SP	@	See note 1		0	0	0	0	0	040	100	00
!	A			0	0	0	0	1	041	101	01
"	B			0	0	0	1	0	042	102	02
#	C			0	0	0	1	1	043	103	03
$	D			0	0	1	0	0	044	104	04
%	E			0	0	1	0	1	045	105	05
&	F			0	0	1	1	0	046	106	06
'	G			0	0	1	1	1	047	107	07
(	H			0	1	0	0	0	050	110	08
)	I			0	1	0	0	1	051	111	09
*	J			0	1	0	1	0	052	112	10
+	K			0	1	0	1	1	053	113	11
,	L			0	1	1	0	0	054	114	12
-	M			0	1	1	0	1	055	115	13
.	N			0	1	1	1	0	056	116	14
/	O			0	1	1	1	1	057	117	15
2	R			1	0	0	1	0	062	122	18
3	S			1	0	0	1	1	063	123	19
4	T			1	0	1	0	0	064	124	20
5	U			1	0	1	0	1	065	125	21
6	V			1	0	1	1	0	066	126	22
7	W			1	0	1	1	1	067	127	23
8	X			1	1	0	0	0	070	130	24
9	Y			1	1	0	0	1	071	131	25
:	Z			1	1	0	1	0	072	132	26
;	[			1	1	0	1	1	073	133	27
<	\			1	1	1	0	0	074	134	28
=	]			1	1	1	0	1	075	135	29
>	~			1	1	1	1	0	076	136	30

Note 1: Only the first five bits of binary code are set into the address switch. These bits are the same for both listen and talk addresses. The 6th and 7th bits are automatically controlled by the controller (calculator) and used to distinguish between listen and talk addresses.

Note 2: The 4271B Option 101 instrument leaves the factory with the HP-IB address switch set for a bit pattern of 10001 which corresponds to decimal code 17, ASCII listen address 1, and ASCII talk address Q.

(a) Accuracy of D (of Capacitance Measurement).

RANGE \ TEST SIGNAL LEVEL	HIGH	LOW
1		
2		
3		
4		

In this Figure:

Nc: capacitance readout displayed in counts.
NG: conductance readout displayed in counts.
NL: inductance readout displayed in counts.
NR: resistance readout displayed in counts.
ND: dissipation factor readout displayed in counts.

Figure 3-3. Accuracy (Sheet 3 of 6).

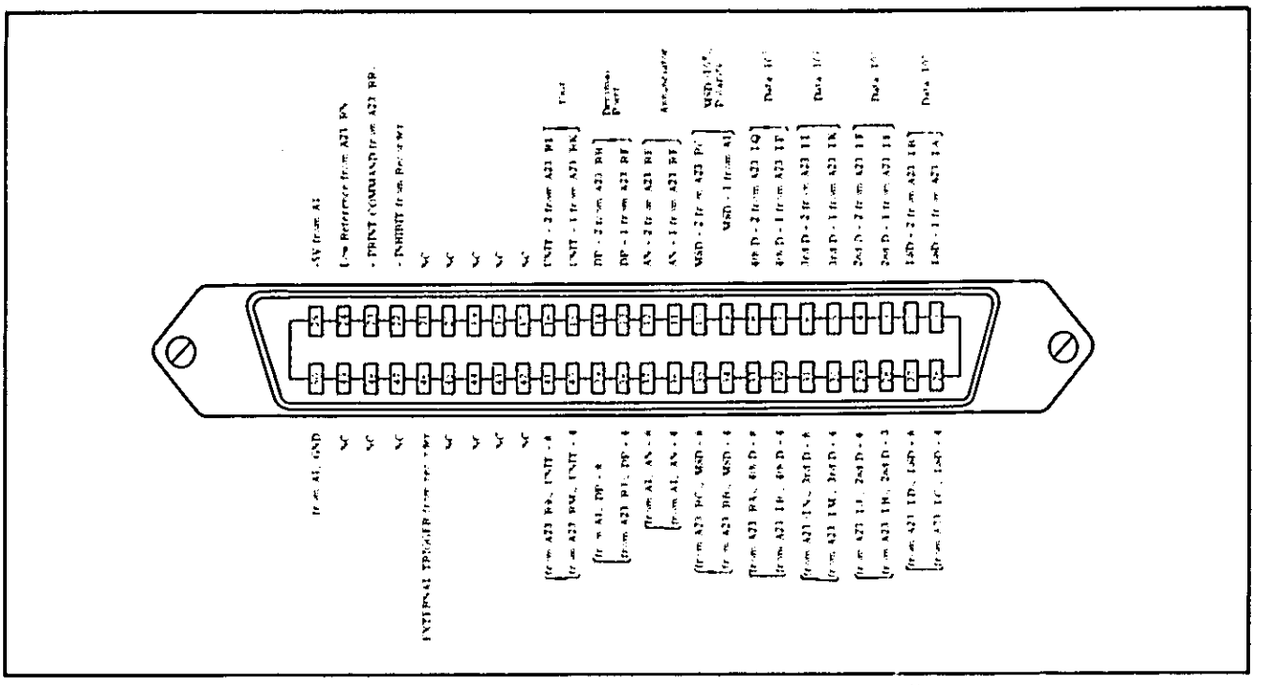


Figure 3-12. Connector Pins and Signals (OPT. 002).

3-81. Option 003 G/R/D BCD Output.

a. HP recorder Model 5055A, 5050B OPT. 051 or 5050B OPT. 050 may be used to record data from a 4271B equipped with OPT. 003. Data measured with bias voltage can also be recorded (except for the bias voltage itself).

b. Refer to Figure 3-14 for typical recording connection configurations. As shown in (1) and (3) of the figures recording is limited to that supplied by option 003 of 4271B. In (2) of Figure 3-14, the 4271B is equipped with both options 002 and 003 and C, L data can be recorded by employing A1J2 of the 5050B OPT. 050.

c. Data formats are given in Table 3-7.

d. Pin connections for option 003 and recorder are shown in Figure 3-15.

e. The timing sequency for OPT. 003 is the same as OPT. 002 except all data is stored in latch memory with END signal. See Figure 3-13.

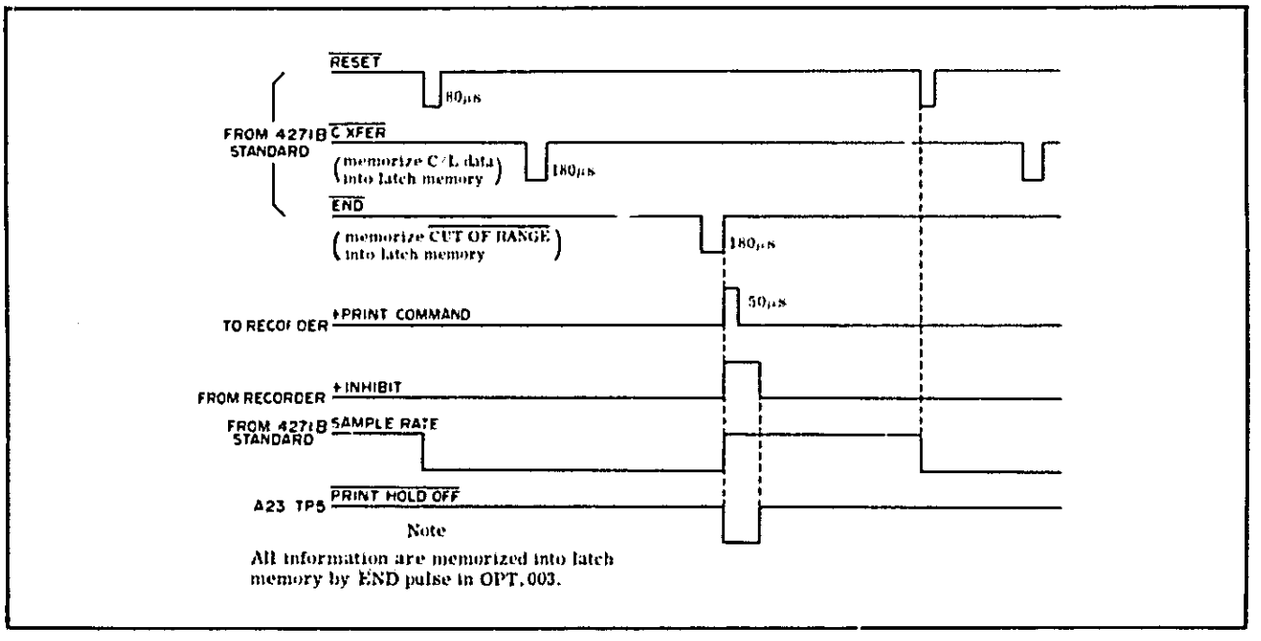


Figure 3-13. Timing Diagram (OPT. 002/003).

b. Format B.

To break the data into two groups (limits line length) for outputting to certain peripherals such as to an HP Model 5150A Thermal Printer, the CR/LF switch on A33 board is set to its "on" position. All data is then outputted in the following format:

XX ±N.NNNN E ±NN (CR) (LF), X ± N.NNNN E ±NN (CR)(LF)

c. Format C.

To output capacitance or inductance only (deletes D, G and R data), the "capacitance and inductance only" switch on A33 board is set to its "C/L only" position. In this mode, either C or L, depending upon FUNCTION programmed, is outputted in this following format:

XX ±N.NNNN E ±NN(CR)(LF)

3-103. Bus Capabilities.

3-104. The capability of a device connected to the Bus is specified by the interface functions built in the device. Table 3-11 lists the interface functions included in the Model 4271B Opt 101. The suffix number or the interface code indicates the limitation of the function capability as defined in Appendix C of IEEE Std. 488-1975.

3-105. Bus Messages.

3-106. Table 3-12 lists characteristic bus messages and describes each. Messages are categorized by Bus function. Most of these messages are routinely used between the 4271B Opt 101 and the controller (calculator). Some of them are not applicable. For example, local lockout is not needed with the 4271B, so it is not featured.

3-107. Message set. The bidirectional traffic (including the program codes) that flows over the HP-IB is described in terms of messages.

The controller orginated messages (commands) are described in Table 3-13 and are in two classes:

1. Addressed	Directions to bus device(s) previously addressed to listen.
2. Universal	Directions to all bus devices capable of responding to the command.

Message[1]	Description	Class	Octal Code	E N	F C	Instrument Response
GET	Group Execute Trigger	AC[3]	010	T		Is triggered (regardless of trigger mode)
MLA	My Listen Address	AC				Becomes addressed to listen.
MTA	My Talk Address	AC				Becomes addressed to talk.
UNL	Unlisten	AC	077			Becomes unaddressed to listen.
UNT	Untalk	AC	137			Becomes unaddressed to talk.
SPE	Serial Poll Enable	UC[2]	030			Configures the 4271B into the serial poll mode.
SPD	Serial Poll Disable	UC	031			Exits serial poll mode.
IFC	Interface Clear	Single Line MSG			T	Unaddress the 4271B as a talker and as a listener and clears serial poll mode.
REN	Remote Enable			T[4]		Programs the 4271B to remote (concurrent with MLA).
				F[5]		Returns the 4271B to local.

1: All multiline (DIO 1-8) messages are sent with ATN true.
2: Universal command.
3: Addressed command.
4: True.
5: False.

Control with Literal Program Codes

When using literals to program a device, use a bus command statement. In composing the CMD (wrt) statement, string the literals to form the program code. Use a command string, in the basic addressing sequence, to address the calculator or computer to talk and other devices to listen. Since the calculator "talk" address is "U", the CMD statement may take the following form:

a. When using an HP 9830A as controller:

```
CMD "?U1", "F1R0V000NE"
```

Unlisten command.
Calculator talk address.
HP 4271B Opt 101 listen address.
Function setting.
Range setting.
DC Bias setting.
No interrupt mode.
Execute (triggering).

Program Codes

```
wrt 717, 'F1R0V000NE"
```

Select code of 98034A HP-IB I/O card.
Address code of 4271B Opt 101 in 5 bit decimal form.

The following statement is useable when the controller has "Extended I/O Programming" capability:

```
cmd 7, "?U1", "F1R0V000NE"
```

Note 1

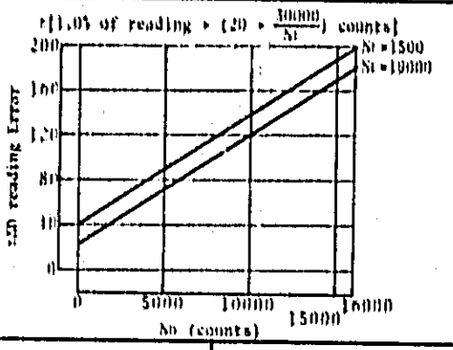
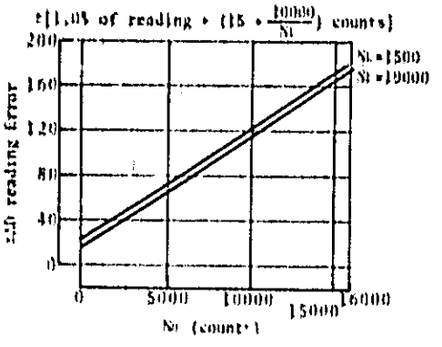
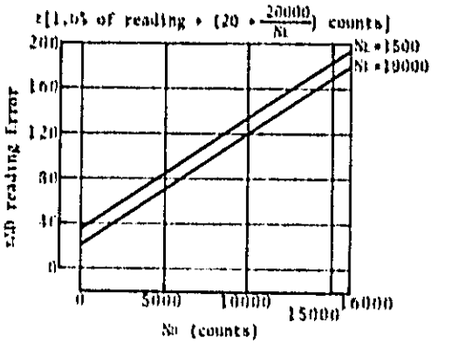
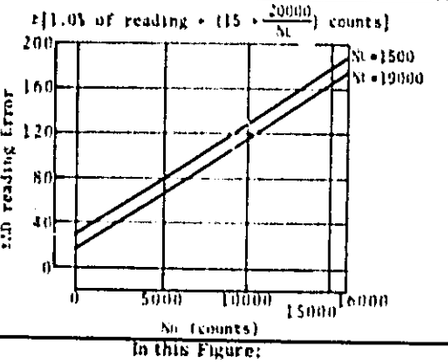
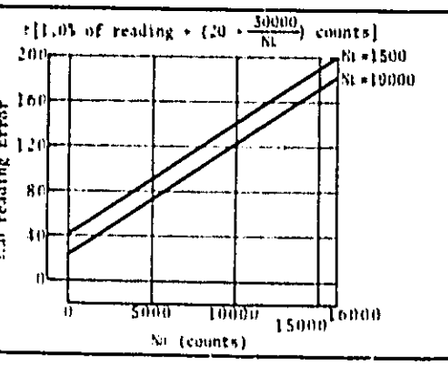
These CMD statements are for the 4271B Opt 101.

Note 2

To change a controlled function or setting, it is only necessary to restate that part of the command string which controls that function or setting.

Figure 3-25. Control with Literal Program Codes.

(f) Accuracy of D (or Inductance Measurement),

RANGE \ TEST SIGNAL LEVEL	HIGH	LOW
1		
2		
3		
4		

In this Figure:

Nc: capacitance readout displayed in counts.
NG: conductance readout displayed in counts.
Nt: inductance readout displayed in counts.
Nr: resistance readout displayed in counts.
No: dissipation factor readout displayed in counts.

Figure 3-3. Accuracy (Sheet 6 of 6).

3-36. Annunciators.

3-37. The three annunciators: "OUT OF RANGE", "UNBAL" and "D→G, R" may be checked by turning them on which is done with these respective, control settings:

a. "OUT OF RANGE" lamp.

FUNCTION ..... L-R
RANGE ..... Any position.
Unknown ..... Open

b. "UNBAL" lamp.

FUNCTION ..... C-G
RANGE 1
Unknown ..... Short

c "D→G, R" lamp.

FUNCTION ..... L-D
RANGE ..... Any position.
TEST SIG LEVEL ..... HIGH or LOW
Unknown ..... Short

Note

"UNBAL" lamp is turned on and off at the same rate as measuring rate lamp. Other annunciator lamps light continuously.

3-38. OFFSET ADJ. Check.

3-39. The OFFSET ADJ. potentiometers may be turned to determine whether their variable range is appropriate (test is independent of sign polarity). Here is how controls are operated to make test:

Note

C and L potentiometers are 10-turn devices; G and R potentiometers are 3/4-turn devices. Adjustments for (C and G) and (L and R) slightly interact with each other.

a. C and G variable range (compensating values) settings:

FUNCTION ..... C-G
RANGE 1
TEST SIG LEVEL ..... HIGH or LOW
TRIGGER ..... INT
RATE ..... Fully cw
DC BIAS VTG (on Rear Panel) ..... OFF
Test Fixture ..... Attach 16038A Test Fixture.
Unknown ..... Open

Compensating Range:

C 1pF
G 1μS

Check variable range of C or G OFFSET by turning C and G potentiometers for minimum reading of C and G displays. For this test (only) variable range check is independent of polarity [minus (-) or plus (no sign)] of readings.

b. L and R OFFSET check settings:

FUNCTION ..... L-R
RANGE 1
TEST SIG LEVEL ..... HIGH or LOW
TRIGGER ..... INT
RATE ..... Fully cw
Test Fixture ..... Attach 16038A Test Fixture.
Unknown ..... Short

Compensating Range:

L 100nH
R 0.1Ω

Note

Check variable range of L or R OFFSET by turning L and R offset potentiometers for minimum reading of L and R displays. The L offset potentiometer is a 10-turn control.

3-40. FUNCTIONS.

3-41. The Model 4271B has five measuring FUNCTIONS: C-G, C-D, L-R, L-D and REMOTE. In C-G or C-D, the 4271B measures an unknown as a capacitance (C) with parallel conductance, and displays the conductance (G) or dissipation factor (D). In L-R or L-D, the instrument measures an unknown as an inductance (L) with series resistance and displays the resistance (R) or dissipation factor (D). Thus, the 4271B measures a sample regarding it as an equivalent circuit as shown in Figure 3-4(A).

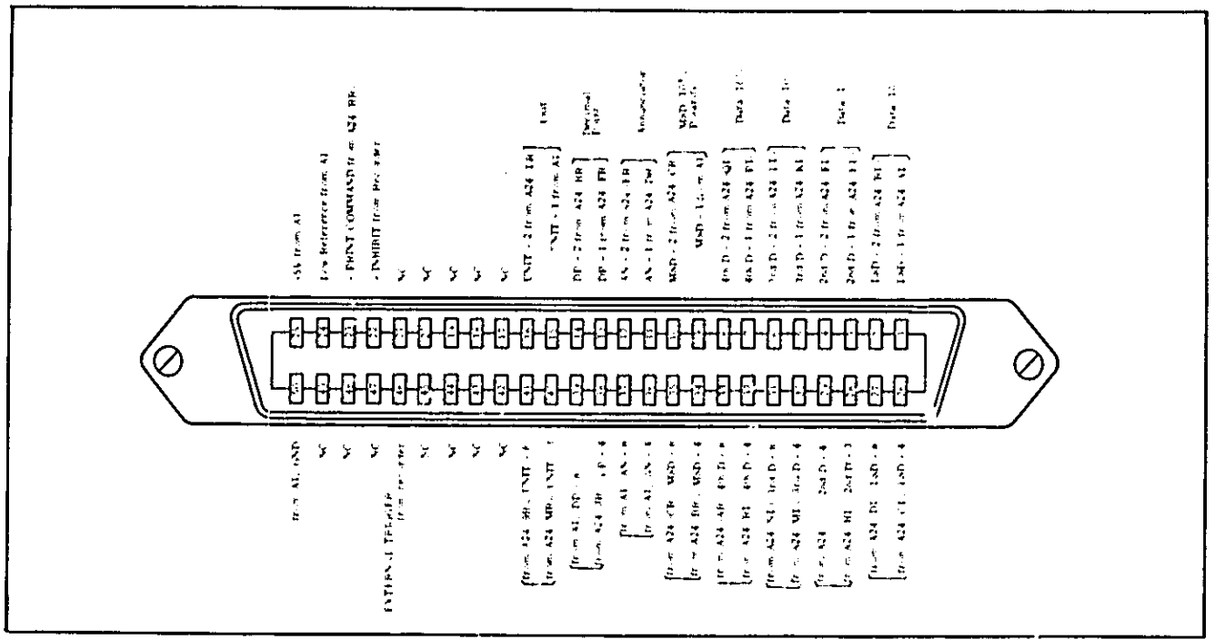


Figure 3-15. Connector Pins and Signa's (OPT. 003).

3-82. Option 004 Parameter Serial BCD Output.

a. Set switch S1 on A25 board to required position: C, G or C/G.

POSITION	PRINT DATA
C	C or L
G	C or R or D
C/G	C/G or C/D or L/R or L/D

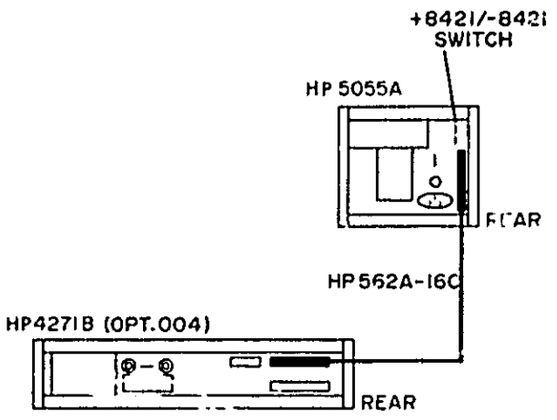
b. Option 004 is used to (alternately) transfer C L data and G R D data in a parallel BCD code. Refer to Figure 3-16. Recorder Models 5055A, 5050B OPT. 051 and 5050B OPT. 050 may be used with a Model 4271B equipped with option 004. Data measured with bias voltage can also be recorded (except for bias voltage itself).

c. Data formats are given in Table 3-8.

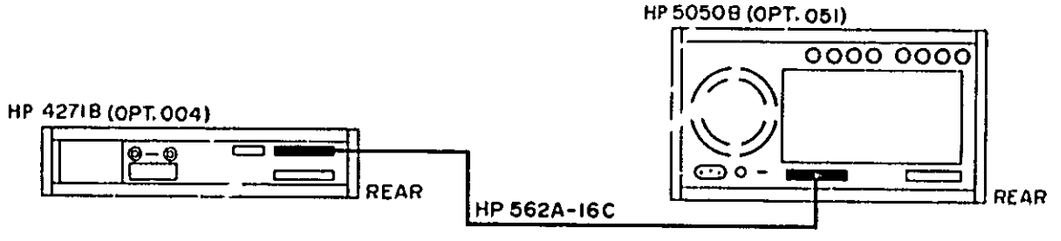
d. Pin connections for option 004 and recorder are shown in Figure 3-17.

e. Figure 3-18 is a timing diagram for option 004 and recorder.

(1) Model 4271B Opt.004 with Model 5055A.
Note: Set +8421/-8421 switch of 5055A (rear panel) to -8421.



(2) Model 4271B Opt.004 with Model 5050B Opt.051.



(3) Model 4271B Opt.004 with Model 5050B Opt.050.

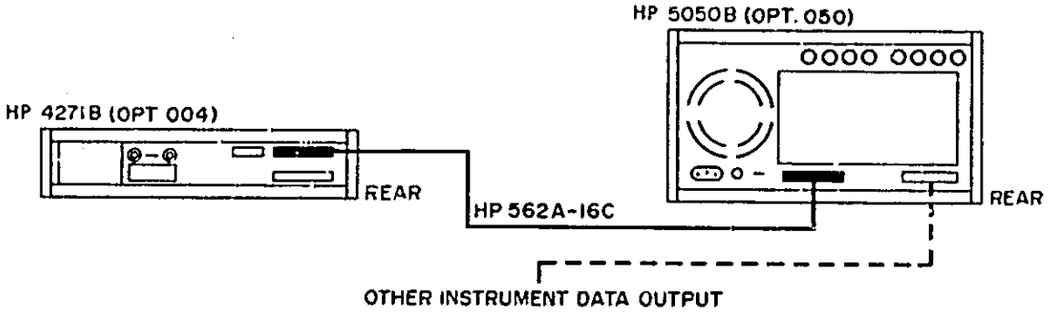


Figure 3-16. Parameter Serial BCD Output (OPT. 004).

Control with Variable Program Codes.

Normally a device is programmed using coding that takes the value of variables stored in the calculator. Usually the variables include the desired output or specify some signal source (e.g. dc bias). By using a FORMAT (fmt) and WRITE (wrt) statement, it is possible to transmit a program code string containing the value of the variable. The CMD statement is still used to address the calculator to talk and to address the device instrument to listen. The following statements show the basic forms which may be used with the 4271B Opt 101 for using variable values as programming codes:

a. When using an HP 9830A as controller:

```
10 CMD "?U1"
20 FORMAT "F", F1000.0, "R",
   F1000.0, "V", F1000.0, "NE"
30 OUTPUT (13, 20) A, B, C
   *10+400
```

?: Unlisten command.
U: Calculator talk address.
1: HP 4271B Opt 101 listen address.
F: Alpha element of program code for FUNCTION.
R: Alpha element of program code for RANGE MODE.
V: Alpha element of program code for DC Bias Voltage.
F1000.0: Conversion specification.
A: Variable, numeric element of program code for FUNCTION.
B: Variable, numeric element of program code for RANGE MODE.
C: Variable, numeric element of program code for DC Bias Voltage.

b. When using an HP 9825A as Controller:

```
0: fmt 1, "F", f.0, "R", f.0,
   "V", fz3.0, "NE"
1: wrt 717.1, A, B, C
```

f.0, fz3.0: Conversion specification.
717.1: 1st digit is the select code and following 2 digits are the address code in 5 bit decimal form. Tenth digit is format number.

CAUTION

WHEN CONTROLLING DC BIAS VOLTAGE OF THE MODEL 4271B OPT 101 WITH A 9830A CALCULATOR, TRANSMITTED VALUE IS REQUIRED BIAS VOLTAGE TIMES 10 PLUS 400 OR TIMES 10 FOR A 9825A.

Note

The above sample programs transmit program code strings that contain instructions for selection of function variables. This statement may include literals as program codes from format list.

Figure 3-26. Control with Variable Program Codes.

. . Receive Measured Data

To receive measured data, following program transfer the data from 4271B to calculator.

Note

If only following program is programmed and executed, it will cause error and no data will be receipt. Be sure, trigger statement,

CMD "?U1", "E" for 9830A,
wrt 717, "E" or trg 717 for 9825A

is respectively required before the program listed below. Refer to Figures 3-28 and 3-29 for actual systemized measurement.

a. When using an HP 9830A as controller:

```
10 CMD "?5Q"
20 ENTER (13, *) A, B
```

?: Unlisten command.
5: Calculator listen address.
Q: HP 4271B Opt 101 talk address.
13: Select code for Bus I/O card.
*: Free field format.
A, B: Data storage registers (2).

b. When using an HP 9825A as controller:

```
0: red 717, A, B
```

717: 1st digit is the calculator I/O card select code and the following two digits are the 4271B Opt 101 address code in 5 bit decimal form.
A, B: Data storage registers (2).

In the above programs, the CMD statement addresses the 4271B Opt 101 to talk and the calculator to listen. The ENTER statement takes incoming data and stores the data item in the register specified in the variable lists. Complete output information from the HP 4271B Opt 101 is stored by the following program by using string variables:

a. When using an HP 9830A as controller:

```
10 DIM A$[26]
20 CMD "?5Q"
30 ENTER (13, *) A$
```

b. When using an HP 9825A as controller:

```
0: dim A$[26]
1: red 717, A$
```

Figure 3-27. Receiving Measured Data.

Note

Remote enable statement sets 4271B Opt 101 to remote enable state and allows remote control of device on the bus.

a. When using an HP 9830A as controller:

10 CMD"?U1", "F1R0V123NE"	Addresses calculator to talk "U" and HP 4271B Opt 101 to listen "1". Program code string sets device to FUNCTION: C-D, RANGE: AUTO, DC BIAS VOLTAGE: 12.3V, and No Interrupt Mode. The 4271B Opt 101 is triggered by program code 'E".
20 CMD "?5Q"	Addresses calculator to listen "5" and HP 4271B Opt 101 to talk "Q".
30 ENTER (13, *) A, B	This statement takes incoming data and stores data items (C-D) in the registers specified in the variable lists.
40 FORMAT "C=", E11.4, "D=", F7.4	Print A and B data.
50 WRITE (15, 40) A, B	
60 END	Program end.

b. When using an HP 9825A as controller:

0: wrt 717, "F1R0V123NE"	Addresses calculator to talk and HP 4271B Opt 101 to listen. Program code string sets device to FUNCTION: C-D, RANGE: AUTO, DC BIAS VOLTAGE: 12.3V, and No interrupt mode. The 4271B Opt 101 is triggered by program code "E".
1: red 717, A, B	The READ statement addresses calculator to listen and HP 4271B Opt 101 to talk and takes incoming data and stores data items (C-D) in the registers specified in the variable lists.
2: flt 4; prt A; fxd 4; prt B	Print data A and B
3: end	Program end.

Note

When complete information is required, use string variables for receiving data (refer to Figure 3-27).

Figure 3-28. Simple Programs - No interrupt mode.

a. When using an HP 9830A as controller:

```
10 CMD "?U1", F1R0V123IE"        Addresses calculator to talk "U" and
                                 4271B Opt 101 to listen "1". Program
                                 code string sets device to FUNCTION:
                                 C-D, RANGE: AUTO, DC BIAS VOLT-
                                 AGE: 12.3V, and Interrupt mode.
                                 The 4271B Opt 101 is triggered by pro-
                                 gram code "E".

20 IF STAT 13 < = 1 THEN 40      Check service request line (SRQ), if
30 GO TO 20                      SRQ line is LOW, go to step 40.

40 CMD "?U"                      Addresses calculator to talk and sends
50 FORMAT 5B                     serial poll enable command (SPE).
60 OUTPUT (13, 50) 256, 95, 53,
   24, 512

70 CMD "Q"                       Addresses HP 4271B Opt 101 to talk.
80 A=RBYTE 13                    Checks HP 4271B Opt 101 response to
                                 SPE on data line DIO7 and stores line
                                 state in calculator.

90 CMD "?U"                      Addresses calculator to talk and sends
100 OUTPUT (13, 50) 256, 25, 512 serial poll disable command (SPD).

110 IF A=64 THEN 130             If data line DIO 7 is LOW, go to step 130.
120 STOP                         If DIO 7 line is HIGH, stop the program.

130 CMD "?5Q"                    Addresses calculator to listen, 4271B
140 ENTER (13, *) A, B           Opt 101 to talk. The enter statement takes
                                 incoming data and stores data items (C-D)
                                 in the registers specified in the variable list.

150 FORMAT "C=", E11.4, "D=",    Print A and B data.
    F7.4
160 WRITE (15, 150) A, B

170 END                          Program end.
```

Note

When complete information is required, use string variables for receiving data (refer to Figure 3-27).

Figure 3-20. Sample Program - Interrupt Mode (Sheet 1 of 2).

b. When using an HP 9826A as controller:

0:	wrt 717, "F1R0V123IE"	Addresses calculator to talk and 4271B Opt 101 to listen. Program code string sets device to FUNCTION: C-D, RANGE: AUTO, DC BIAS VOLTAGE: 12.3V and interrupt mode. The 4271B Opt 101 is triggered by program code "E".
1:	rds (7)→A; jmp A > = 236	Check service request line (SRQ); if SRQ line is LOW, go to step 2.
2:	rds (717)→A; jmp A = 64	Check 4271B Opt 101 response to SPE on data line DIO7. If DIO7 is LOW, go to step 3.
3:	red 717, A, B	Addresses calculator to listen and 4271B Opt 101 to talk. The red statement takes incoming data and stores data items (C-D) in the registers specified in the variable lists.
4:	flt 4; prt "C=", A; fxd 4; prt "D=", B	Print A and B data.
5:	end	Program end.

Figure 3-29. Sample Program - Interrupt Mode (Sheet 2 of 2).

Table 4-1. Recommended Test Equipment.

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
Standard Capacitor 1 pF 10 pF 100 pF 1000 pF 10 nF	The effect of auxiliary adapters must be either negligible at 1MHz or included in the calibrated value of the standard.	General Radio 1405 - E 1405 - B 1406 - D 1406 - A 1407 - D
Standard Resistor 0 Ω 100 Ω		General Radio 900 - WN 900 - W100
Capacitor 15 pF 18 pF 1000 pF 7500 pF	 ±5% ±5% ±5% ±5%	HP P/N: 0160-2261 0160-2322 0160-2218 0160-2355
Inductor 200 μH 470 μH 1000 μH	 ±5% ±5% ±5%	HP P/N: 9140-0237 9100-1647 9140-0137
Resistor 100 Ω 200 Ω 1.95 kΩ 5.11 kΩ 19.6 kΩ 1 MΩ	 ±1% ±0.5% ±0.1% ±1% ±1% ±5%	HP P/N: 0757-0401 0698-3186 0698-5419 0757-0438 0698-3157 0698-1055
Decade Capacitor	40pF - 1.2μF with 40pF - 180pF Vernier.	HP Model 4440B
Frequency Selective Voltmeter	Frequency 1kHz - 18MHz, Voltage 3μV - 3V.	HP Model 312B
Digital Voltmeter	Accuracy ±0.01%, Input - Imp. > 10MΩ.	HP Model 3490A
Function Generator	Frequency > 0.01Hz, Voltage >5V.	HP Model 3310A
Oscilloscope	Sensitivity 5mV/Div., Frequency 10MHz.	HP Model 180A 1801A 1821A
Logic Probe	Input impedance 10kΩ.	HP Model 10525T.
Pulse Generator	Output > 5V, Rise time 1μsec, Pulse width > 50μsec.	HP Model 214A
Function Generator	Output > 5V, Frequency ≈ 2 - 3Hz	HP Model 3310A
Test Fixture		HP Model 16021A 16022A
AC Voltmeter	3mV - 300V, 10Hz - 10MHz.	HP Model 400E
Electronic Tool	A10 Adjustment Kit.	ET - 1467
Frequency Counter	10 to 10MHz, Input impedance 1MΩ.	HP 5300 w 5301A
DC Power Supply	0 to 20V, 0.01%.	HP 6201B

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION.

4-2. This section provides the check procedures that verifies the 4271B specifications listed in Table 1-1. All tests can be performed without access to the interior of the instrument. A simpler operational test is presented in Section III. The performance test procedures in this section can also be used to do an incoming inspection of the instrument and to verify whether the instrument meets its specified performance after troubleshooting or making adjustments. If specifications are found to be out of limits, check that controls are properly set, and then proceed to adjustments or troubleshooting.

Note

Allow a 60-minute warm-up and stabilization period before conducting any performance test.

4-3. EQUIPMENT REQUIRED.

4-4. Equipment required for the performance tests is listed in Table 4-1 Recommended Test Equipment. Any equipment whose characteristics equal the critical specifications given in the table may be substituted for the recommended model(s).

Note

Standard Capacitors including connecting cables should be traceable to NBS calibration, JEMIC, or equivalent calibrated data should be known and accuracy should be within limits listed in Table 4-2.

4-5. TEST RECORD.

4-6. Results of the performance tests may be tabulated on the Test Record at the end of these procedures. The Test Record lists all the tested specifications and their acceptable limits. The results for comparison in periodic maintenance and troubleshooting and after repairs or adjustments.

4-7. CALIBRATION CYCLE.

4-8. This instrument requires periodic verification of performance. Depending on the use and environmental conditions, the instrument should be checked with the following performance test at least twice every year. To maximize the "up time" of the instrument, the recommended preventive maintenance frequency for the 4271B is twice a year.

Table 4-2. Accuracy Specifications for Standard Instruments and Recommended Calibration Intervals.

STANDARD	CALIBRATION ACCURACY	RECOMMENDED CALIBRATION INTERVAL
*GR 1405-E	0.2 % at 1kHz	Every 3 Months
*GR 1405-B	0.04 % at 1kHz	" 2 Months
*GR 1406-D	0.02 % at 1kHz	" 5 Months
**GR 1406-A	0.02 % at 1kHz	" 4 Months
***GR 1407-D	0.015 % at 1kHz	" Year
****GR 900-W100	0.01 % at DC	" Year

* $C_{1MHz} = C_{1kHz}$, $G_{1MHz} = 0$

** $C_{1MHz} = 1.0003 \times C_{1kHz}$, $G_{1MHz} = 0$

*** $C_{1MHz} = 1.003 \times C_{1kHz}$, $G_{1MHz} = 0.03mS$

**** $R_{1MHz} = R_{DC}$, $L_{1MHz} = -0.016\mu H$

$G_{1MHz} = \frac{1}{R_{DC}}$, $C_{1MHz} = 1.6pF$

4-9. ACCURACY CHECK.

4-10. Zero Accuracy Check.

a. Set 4271B controls as follows:

FUNCTION ..... C-G
RANGE 1
TEST SIG LEVEL ..... HIGH
TRIGGER ..... INT
RATE ..... FULL CW
TEST FIXTURE 16021A
LINE ..... ON

b. Connect GR 1405-E to 16021A. Adjust C OFFSET ADJ for calibrated value ±1 count and G OFFSET ADJ for 00.00 ±1 count. Remove GR 1405-E.

c. Set FUNCTION to L-R and connect GR-900WN to 16021A.

d. Adjust L OFFSET ADJ for 000.0 ±1 count and R OFFSET ADJ for 0.000 ±1 count.

e. Set RANGE to 2, 3 and 4 and confirm that L and R readings are in accord with Table 4-3. Remove GR-900WN.

f. Set RANGE to 1 and adjust L OFFSET ADJ for 000.0 ±1 count and R OFFSET ADJ for 0.000 ±1 count.

g. Set FUNCTION to C-G and connect GR 1405-E to 16021A.

h. Adjust C OFFSET ADJ for calibrated value ±1 count and G OFFSET ADJ for 00.00 ±1 count.

i. Set RANGE to 2, 3 and 4 and confirm C and G readings are in accord with Table 4-4.

j. Repeat step a to i with TEST SIG LEVEL set to LOW.

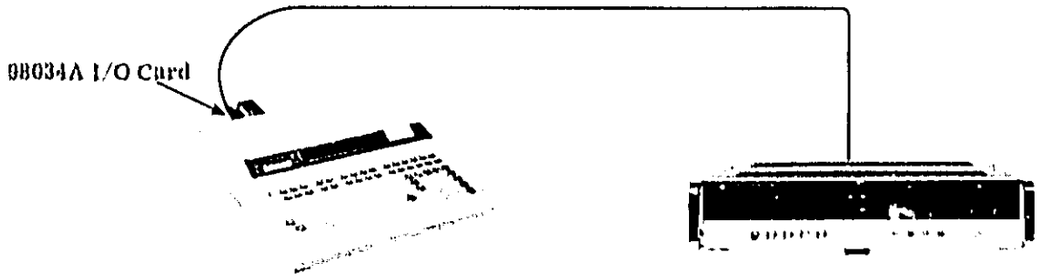
Table 4-3. L-R Zero Check.

TEST SIG LEVEL	RANGE	1	2	3	4
HIGH	L reading	000.0 ±1 count	0.000 ±4 counts	00.00 ±4 counts	000.0 ±4 counts
	R reading	0.000 ±1 count	00.00 ±4 counts	000.0 ±4 counts	0.000 ±4 counts
LOW	L reading	000.0 ±1 count	0.000 ±6 counts	00.00 ±6 counts	000.0 ±6 counts
	R reading	0.000 ±1 count	00.00 ±4 counts	000.0 ±4 counts	0.000 ±4 counts

Table 4-4. C-G Zero Check.

TEST SIG LEVEL	RANGE	1	2	3	4
HIGH	C reading	C.V.* ±1 count	C.V. ±3 counts	C.V. ±2 counts	C.V. ±3 counts
	G reading	00.00 ±1 count	000.0 ±4 counts	0.000 ±4 counts	00.00 ±4 counts
LOW	C reading	C.V. ±1 count	C.V. ±4 counts	C.V. ±3 counts	C.V. ±3 counts
	G reading	00.00 ±1 count	000.0 ±5 counts	0.000 ±4 counts	00.00 ±4 counts

*C.V. = CALIBRATED VALUE



Model 9825A Calculator with Model 4271B Opt 101 1MHz LCR Meter.

Operation

a. Set control switches on 4271B Opt 101 rear panel.

Typical Settings:

A5-A1: 10001 (17 in 5 bit decimal form) or appropriate address.
HOLD: 0 (non-hold position).
TALK ONLY ADDRESSABLE: ADDRESSABLE.

b. Connect interface bus cable to 4271B Opt 101 and 9825A.

c. Turn on instruments.

d. Set 4271B Opt 101 front panel controls as follows:

FUNCTION: REM
RANGE: REM
TRIGGER: EXT MAN
TEST SIG LEVEL: HIGH or LOW as desired.

e. Operate system with controller (calculator program).

Figure 3-30. Operating a 4271B Opt 101 System.

```
0: wrt 717, "F1R0V000N"
1: fmt 1, "V", fz3.0, "E"
```
Initial settings for: FUNCTION to C-D, RANGE to AUTO, DC BIAS VOLTAGE to 0V, and No Interrupt Mode.

```
2: ent "DC BIAS (V)", A
```
Store desired DC Bias voltage as variable A.

```
3: wrt 717.1, A*10
```
Transmits DC Bias setting. Note that the value transmitted is stored value times ten.

```
4: red 717, X, Y
```
Receive data (C-D) and store as variables X and Y.

```
5: flt 4; prt "C=", X; fxd 4; prt "D=", Y
```
Print data X and Y.

```
6: end
```
Program end.

Figure 3-31. DC Bias Control with HP 9825A.

Bit	8	7	6	5	4	3	2	1
Information	0	SRQ	0	0	0	UNBAL	OUT OF RANGE	D→G
Decimal	128	64	32	16	8	4	2	1

Bit 1: Goes to "1" when D—►G lamp is lit.
Bit 2: Goes to "1" when OUT OF RANGE lamp is lit.
Bit 3: Goes to "1" when UNBAL lamp is lit.
Bit 4: Not used.
Bit 5: Not used.
Bit 6: Not used.
Bit 7: Goes to "1" when measurement is completed.
Bit 8: Not used.

The Status Byte is sent from 4271B to controller when a serial poll is performed in interrupt mode. Controller checks the status byte to determine which equipment is requesting service. The status byte is a way of reporting instrument operating information to the controller. The status byte is stored as sum of state "1" bits in decimal form (e.g. if only SRQ, 64 is stored .... if both SRQ and UNBAL, 68 is stored).

Figure 3-32. Status Byte.

PERFORMANCE TESTS

4-11. Capacitance Accuracy Check.

a. Connect Standard Capacitance shown in Table 4-5.

b. Reading of 4271B should be within limits specified in Table 4-5.

Table 4-5. Capacitance Accuracy Check.

TEST SIG LEVEL	RANGE	1	2	3	4
	Standards	1405-B 10 pF	1406-D 100 pF	1406-A 1000pF	1407-D 10 nF
HIGH	C reading	C.V.*±17 counts	C.V. ±13 counts	C.V. ±12 counts	C.V. ±43 counts
	G reading	00.00 ±17 counts	000.0 ±13 counts	0.000 ±22 counts	00.03 mS ±22 counts
LOW	C reading	C.V. ±28 counts	C.V. ±24 counts	C.V. ±23 counts	C.V. ±43 counts
	G reading	00.00 ±27 counts	000.0 ±23 counts	0.000 ±22 counts	00.03 mS ±22 counts

*C.V: CALIBRATED VALUE.

4-12. Conductance and Resistance Accuracy Check.

a. Connect GR-900W100 to 16021A.

b. Set 4271B controls as follows:

TEST SIG LEVEL ..... HIGH (or LOW)
RANGE 3
FUNCTION ..... C-G
TRIGGER ..... INT
RATE ..... FULL CW

c. Reading of G/R display should be *calibrated value of GR-900W100 ±124 counts.

$$*G = \frac{1}{R: \text{calibrated}}$$

d. Reading of C/L display at HIGH LEVEL should be 1.6pF ±20 counts.
Reading of C/L display at LOW LEVEL should be 1.6pF ±21 counts.

e. Set FUNCTION to L-R and RANGE to 2.

f. Reading of G/R display should be calibrated value of GR-900W100 ±124 counts.

g. Reading of C/L display at HIGH LEVEL should be -0.016μH ±22 counts.
Reading of C/L display at LOW LEVEL should be -0.016μH ±24 counts.

4-13. Dissipation Factor Accuracy Check.

Note

Dissipation factor accuracy check should be done after completing capacitance and resistance accuracy checks.

a. Set 4271B controls as follows:

FUNCTION ..... C-G
RANGE 3
TEST LEVEL..... HIGH (or LOW)
RATE ..... FULL CW
DC BIAS VTG..... OFF

b. Connect HP 16038A to UNKNOWN of 4271B.

c. Connect a capacitance (≈*1000pF) in parallel with resistance (≈**200Ω) to 16038A.

P/N's are: * 0160-2218
** 0698-3186

d. Calculate: Reading of G/(6.283 x 10^6 x Reading of C).

e. Set FUNCTION to C-D.

f. Reading of D at HIGH LEVEL should be:

Calculated value ± calculated value :: 1% ±11 counts.

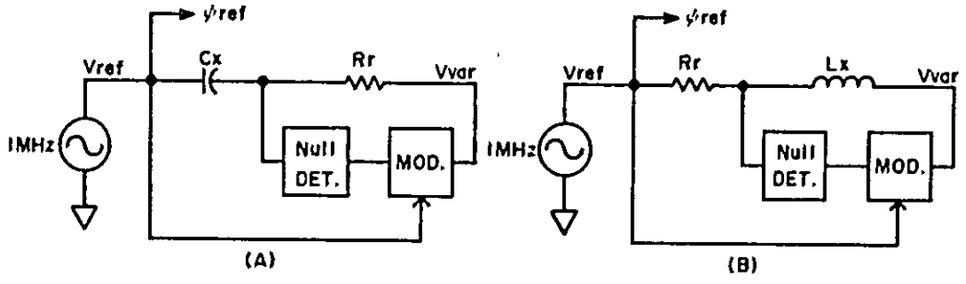
Reading of D at LOW LEVEL should l

Calculated value ± calculated ue x 1% ±17 counts.

4-14. Inductance Accuracy Check.

4-15. Generally, an inductance value can not be accuracy certified at a high frequency because of the various residual factors incident to connection of the terminals, leads, and the inductor being measured. Hence, inductance standards available and applicable for the verification of 4271B inductance accuracies are almost non-existent.

Fortunately, the 4271B, basically, does not require the use of calibration equipment or standard inductors for testing or establishing its inductance accuracies. Model 4271B inductance accuracies are theoretically established by the equivalency principle. That is, inductance measurement accuracies are established and guaranteed by calibration of the capacitance measurement accuracies in the 4271B.



ψref: phase reference for phase detector.

Figure 4-1. Simplified C/L Bridge Circuits.

The Figure 4-1 above shows simplified bridge circuit configurations of the 4271B for both capacitance and inductance measurements. Since this bridge circuit is automatically balanced in an exact fashion, voltages V_{ref} and V_{var} (representing the unknown impedances) are established with accuracies equal to the accuracy of range resistor Rr. It is important to note that Rr is common to both capacitance and inductance measurements. As may be seen in Figure 4-1, the unknown and range resistor Rr can be inverse connected so that the bridge circuit configuration is appropriate to the DUT.

The phase reference (ψ_{ref}) from the oscillator is uniform in phase regardless of the characteristics of the unknown. Thus, the phase accuracy of the reference phase (used to synchronously detect V_{var} signal) is independent of the measurement mode.

The design of 4271B circuitry took careful consideration of the residual impedances to enable bringing the inductance accuracies into specifications at the same time that the instrument is calibrated for capacitance accuracy.

The 4271B inductance accuracies have been corroborated by comparing 4271B units with other RF inductance measuring equipment and by measurements with accurately calibrated inductors using strict experimental and mathematical compensation to eliminate residual factors from the measured value.

4-16. Internal Bias Voltage Supply (OPT.001).

a. Connect instrument as shown in Figure 4-2.

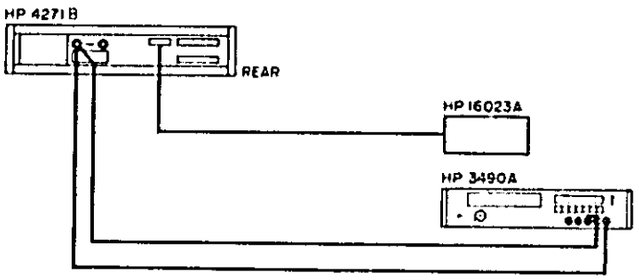


Figure 4-2. Internal Bias Voltage Supply Check.

b. Set 4271B controls as follows:

FUNCTION ..... C-G
RANGE ..... AUTO
TRIGGER ..... INT
RATE ..... FULL CW
TEST SIG LEVEL ..... HIGH (or LOW)
DC BIAS VTG ..... INT (Rear Panel)

c. Set 16023A BIAS VOLTAGE CONTROL as in Table 4-6 and confirm the voltmeter reading as given in Table 4-6.

Table 4-6. Bias Voltage Accuracy Check.

16023A SETTING	VOLTMETER READING
0.0 V	-0.005 ~ 0.005 V
0.1 V	0.0948 ~ 0.1052 V
0.2 V	0.1946 ~ 0.2054 V
0.5 V	0.4940 ~ 0.5060 V
1.0 V	0.9930 ~ 1.0070 V
2.0 V	1.991 ~ 2.009 V
5.0 V	4.985 ~ 5.015 V
10.0 V	9.975 ~10.025 V
20.0 V	19.955 ~20.05 V
39.9 V	39.81 ~39.99 V

4-17. Interface Check (OPT's 002, 003 and 004).

4-18. In this paragraph, interface information between 4271B option instrument and the external device is presented. This information may be used to isolate the instrument (4271B option instrument or the external device) which is malfunctioning. First, completely disconnect external device from the 4271B option instrument. A 4271B option instrument is checked by using interfacing signals which are inputted or outputted through 4271B rear connector. These checks help to determine which instrument is faulty. Table 4-7, 8 and 9 show signals and pin numbers at rear connectors for options 002, 003 and 001. These tables may also be used for component level troubleshooting in Section VIII.

Table 4-7. Signals and Pin Numbers at Connector J12 (Rear Panel) for OPT. 002.

(a) DATA.

DISPLAY	PIN NUMBERS				DIGIT
	1	2	26	27	10^0
	3	4	28	29	10^1
	5	6	30	31	10^2
	7	8	32	33	10^3
0	L	L	L	L	
1	H	L	L	L	
2	L	H	L	L	
3	H	H	L	L	
4	L	L	H	L	
5	H	L	H	L	
6	L	H	H	L	
7	H	H	H	L	
8	L	L	L	H	
9	H	L	L	H	

(b) DATA/SIGN.

DISPLAY	PIN NUMBERS				DIGIT
	9	10	34	35	10^4
1	H	L	L	L	
-	H	H	L	H	
Blank	H	H	H	H	

(c) ANNUNCIATOR.

DISPLAY	PIN NUMBERS			
	11	12	36	37
"OUT OF RANGE" or "UNBAL"	L	L	H	H
Blank	H	H	H	H

(d) DATA MULT.

DISPLAY	PIN NUMBERS			
	13	14	38	39
000.0×10^{-1}	H	L	L	L
00.00×10^{-2}	L	H	L	L
0.000×10^{-3}	H	H	L	L

(e) UNIT.

DISPLAY	PIN NUMBERS			
	15	16	40	41
pF	H	L	L	L
nF	H	H	L	L
mH	H	L	H	L
μH	H	H	H	L

Table 4-8. Signals and Pin Numbers at Connector J11 (Rear Panel) for OPT. 003.

(a) DATA.

DISPLAY	PIN NUMBERS				DIGIT
	1	2	26	27	10^0
	3	4	28	29	10^1
	5	6	30	31	10^2
	7	8	32	33	10^3
0	L	L	L	L	
1	H	L	L	L	
2	L	H	L	L	
3	H	H	L	L	
4	L	L	H	L	
5	H	L	H	L	
6	L	H	H	L	
7	H	H	H	L	
8	L	L	L	H	
9	H	L	L	H	

(b) DATA/SIGN.

DISPLAY	PIN NUMBERS				DIGIT
	9	10	34	35	10^4
1	H	L	L	L	
-	H	H	L	H	
Blank	H	H	H	H	

(c) ANNUNCIATOR.

DISPLAY	PIN NUMBERS			
	11	12	36	37
"OUT OF RANGE" or "UNBAL"	L	L	H	H
"D=G, R" only	H	L	H	H
Blank	H	H	H	H

(d) DATA MULT.

DISPLAY	PIN NUMBERS			
	13	14	38	39
000.0×10^{-1}	H	L	L	L
00.00×10^{-2}	L	H	L	L
0.000×10^{-3}	H	H	L	L
$.0000 \times 10^{-4}$	L	L	H	L

(e) UNIT.

DISPLAY	PIN NUMBERS			
	15	16	40	41
D	L	L	L	L
μS	L	H	L	L
mS	L	L	H	L
Ω	L	H	H	L
kΩ	L	L	L	H

Table 4-9. Signals and Pin Numbers at Connector J11 (Rear Panel) for OPT. 004.

(a) DATA.

DISPLAY	PIN NUMBERS				DIGIT
	1	2	26	27	10^0
	3	4	28	29	10^1
	5	6	30	31	10^2
	7	8	32	33	10^3
0	H	H	H	H	
1	L	H	H	H	
2	H	L	H	H	
3	L	L	H	H	
4	H	H	L	H	
5	L	H	L	H	
6	H	L	L	H	
7	L	L	L	H	
8	H	H	H	L	
9	L	H	H	L	

(b) DATA/SIGN.

DISPLAY	PIN NUMBERS				DIGIT
	9	10	34	35	10^4
1	L	H	H	H	
-	L	L	H	L	
Blank	L	L	L	L	

(c) ANNUNCIATOR.

DISPLAY	PIN NUMBERS			
	11	12	36	37
"OUT OF RANGE" or "UNBAL"	H	H	L	L
"D►G, R" only	L	H	L	L
Blank	L	L	L	L

(d) DATA MULTIPLIER.

DISPLAY	PIN NUMBERS			
	13	14	38	39
000.0	L	H	H	H
00.00	H	L	H	H
0.000	L	L	H	H
.0000	H	H	L	H

(e) UNIT.

DISPLAY	PIN NUMBERS			
	15	16	40	41
pF	L	H	H	H
nF	L	L	H	H
nH	L	H	L	H
μH	L	L	L	H
D	H	H	H	H
μS	H	L	H	H
mS	H	H	L	H
Ω	H	L	L	H
kΩ	H	H	H	L

4-19. HP-IB Interface Check (OPT. 101).

4-20. This paragraph provides test procedures to verify that the Option 101 circuitry installed in a Model 4271B 1MHz Digital LCR Meter is performing satisfactorily. The performance test procedure in this paragraph can also be used to do an incoming inspection of the Option 101 section of the 4271B or to verify that the option section is performing properly after adjustment or troubleshooting. Equipment required for making a performance test ofthe Option 101 section consists of a controller (calculator or computer), interconnecting c 'le, and test program. These are listed in the procedures that follow. The tests co. .sts of two major checks:

a. an ADDRESS TEST,

and

b. an INTERFACE TEST.

Figures 4-3 and 4-4 describe and provide procedures and programs for making the ADDRESS and INTERFACE tests, respectively.

ADDRESS TEST

DESCRIPTION:

This test checks the fundamental Listen and Talk interface states of the HP-IB option section which are defined by address switch settings.

EQUIPMENT:

Controller	Typically 9830A with 59405A HP-IB I O card (Opt 030) and 11272B Ext I O ROM 9825A with 98034A I O card and 98213A Gen I O + EXT I O ROM (note: other similar configurations may operate satisfactorily).
Bus Cable	10631B

PROCEDURE:

a. Connect controller to 4271B Opt 101 with the bus cable.

b. Set CONTROL SWITCH to ADDRESSABLE position.

c. Load address test program in the controller (test programs are given in sheet 2 of this figure).

d. Run test program.

e. Set address switches, A1-A5, on rear panel as directed by controller display.

f. Continue the test program [depress CONT and EXECUTE keys (9830A) in order or depress CONTINUE (9825A) key].

g. Repeat steps e to f for other address settings.

See Sheet 2 for programs.

(procedures)

Figure 4-3. ADDRESS TEST - HP-IB Interface Check 1 (Sheet 1 of 2).

ADDRESS TEST

PROGRAMS

For 9830A Calculator

```
 10 REM ADDRESS TEST PROGRAM 9830A
 20 DISP "SET A5-A1 TO 00001"
 30 STOP
 40 CMD "?!"
 50 WAIT 5000
 60 CMD "?A"
 70 WAIT 5000
 80 CMD "?"
 90 DISP "SET A5-A1 TO 00011"
100 STOP
110 CMD "?#"
120 WAIT 5000
130 CMD "?C"
140 WAIT 5000
150 CMD "?"
160 DISP "SET A5-A1 TO 00100"
170 STOP
180 CMD "?$"
190 WAIT 5000
200 CMD "?D"
210 WAIT 5000
220 CMD "?"
230 DISP "SET A5-A1 TO 01000"
240 STOP
250 CMD "?("
260 WAIT 5000
270 CMD "?H"
280 WAIT 5000
290 CMD "?"
300 DISP "SET A5-A1 TO 10000"
310 STOP
320 CMD "?0"
330 WAIT 5000
340 CMD "?P"
350 WAIT 5000
360 CMD "?"
370 DISP "TEST COMPLETE"
380 END
```

(A)

For 9825A Calculator

```
 0: "ADDRESS TEST PROGRAM BY 9825A":
 1: dsp "SET A5-A1 TO 00001"
 2: stp
 3: cmd 7, "?!"
 4: wait 5000
 5: cmd 7, "?A"
 6: wait 5000
 7: cmd 7, "?"
 8: dsp "SET A5-A1 TO 00011"
 9: stp
10: cmd 7, "?#"
11: wait 5000
12: cmd 7, "?C"
13: wait 5000
14: cmd 7, "?"
15: dsp "SET A5-A1 TO 00100"
16: stp
17: cmd 7, "?$"
18: wait 5000
19: cmd 7, "?D"
20: wait 5000
21: cmd 7, "?"
22: dsp "SET A5-A1 TO 01000"
23: stp
24: cmd 7,"?("
25: wait 5000
26: cmd 7, "?H"
27: wait 5000
28: cmd 7, "?"
29: dsp "SET A5-A1 TO 10000"
30: stp
31: cmd 7, "?0"
32: wait 5000
33: cmd 7, "?P"
34: wait 5000
35: cmd 7, "?"
36: dsp "TEST COMPLETE"
37: end
```

(B)

(programs)

Figure 4-3. ADDRESS TEST - HP-IB Interface Check 1 (Sheet 2 of 2).

INTERFACE TEST

DESCRIPTION:

The Option 101 section of the 4271B controls the functions of the basic measuring instrument and transfers the measured data. The purpose of the interface test is to assure that correct control action and data transfer is occurring.

EQUIPMENT:

Controller	9830A/59405A (Opt 030) 11272B/ 11274B String Variables ROM or 9825A/98034A/98213A/98210A String-Advanced Programming ROM.
Bus Cable	10631B

PROCEDURE:

a. Connect controller to 4271B with the bus cable.

b. Set control switches to ADDRESSABLE, non HOLD position, and A5 - A1 address switches to 10001 (address setting: Listen ... 1, Talk ... Q).

c. Connect 1000pF capacitor to the UNKNOWN terminals of the 4271B.

d. Load interface test program in the controller.

e. Run test program.

f. Check calculator display against the instrument display.

PROGRAMS

For 9830A Calculator

```
10 DIM A$[26]
20 CMD "?U1", "F1R0V000NE"
30 CMD "?5Q"
40 ENTER (15, *) A$
50 DSP A$
60 END
```

For 9825A Calculator

```
0: dim A$[26]
1: wrt 717, "F1R0V000N"
2: trg 717
3: red 717, A$
4: dsp A$
5: end
```

Note

"C" and "D" data should be same as displayed by the instrument.

Figure 4-4. INTERFACE TEST - HP-IB Interface Check 2.

PERFORMANCE CHECK TEST CARD

Hewlett-Packard
Model 4271B
1MHz DIGITAL LCR METER
Serial No.: _____

Tested by: _____

Date: _____

Paragraph Number	Test			Results		
				Minimum	Actual	Maximum
4-9	ACCURACY CHECK					
4-10	Zero Accuracy Check					
	L	HIGH	RANGE 2	- 4 counts	_____	+ 4 counts
			RANGE 3	- 4 counts	_____	+ 4 counts
			RANGE 4	- 4 counts	_____	+ 4 counts
	L	LOW	RANGE 2	- 6 counts	_____	+ 6 counts
			RANGE 3	- 6 counts	_____	+ 6 counts
			RANGE 4	- 6 counts	_____	+ 6 counts
	R	HIGH	RANGE 2	- 4 counts	_____	+ 4 counts
			RANGE 3	- 4 counts	_____	+ 4 counts
			RANGE 4	- 4 counts	_____	+ 4 counts
	R	LOW	RANGE 2	- 4 counts	_____	+ 4 counts
			RANGE 3	- 4 counts	_____	+ 4 counts
			RANGE 4	- 4 counts	_____	+ 4 counts
	C	HIGH	RANGE 2	C.V. -3 counts	_____	C.V. +3 counts
			RANGE 3	C.V. -2 counts	_____	C.V. +2 counts
			RANGE 4	C.V. -3 counts	_____	C.V. +3 counts
	C	LOW	RANGE 2	C.V. -4 counts	_____	C.V. +4 counts
			RANGE 3	C.V. -3 counts	_____	C.V. +3 counts
			RANGE 4	C.V. -3 counts	_____	C.V. +3 counts
	G	HIGH	RANGE 2	-4 counts	_____	+4 counts
			RANGE 3	-4 counts	_____	+4 counts
			RANGE 4	-4 counts	_____	+4 counts
	G	LOW	RANGE 2	-5 counts	_____	+5 counts
			RANGE 3	-4 counts	_____	+4 counts
			RANGE 4	-4 counts	_____	+4 counts
4-11	Capacitance Accuracy Check					
	C	HIGH	RANGE 1	C.V. -17 counts	_____	C.V. +17 counts
			RANGE 2	C.V. -13 counts	_____	C.V. +13 counts
			RANGE 3	C.V. -12 counts	_____	C.V. +12 counts
			RANGE 4	C.V. -43 counts	_____	C.V. +43 counts

*C.V.: CALIBRATED VALUE.

Paragraph Number	Test			Results		
				Minimum	Actual	Maximum
4-11	Capacitance Accuracy Check (Continued)					
	C	LOW	RANGE 1	C. V. -28 counts	_____	C. V. +28 counts
			RANGE 2	C. V. -24 counts	_____	C. V. +24 counts
			RANGE 3	C. V. -23 counts	_____	C. V. +23 counts
			RANGE 4	C. V. -43 counts	_____	C. V. +43 counts
	G	HIGH	RANGE 1	-17 counts	_____	+17 counts
			RANGE 2	-13 counts	_____	+13 counts
			RANGE 3	-22 counts	_____	+22 counts
			RANGE 4	-19 counts	_____	+25 counts
	G	LOW	RANGE 1	-27 counts	_____	+27 counts
			RANGE 2	-23 counts	_____	+23 counts
			RANGE 3	-22 counts	_____	+22 counts
			RANGE 4	-19 counts	_____	+25 counts
4-12	Conductance and Resistance Accuracy Check					
	G	HIGH	RANGE 3	C. V.* -124 counts	_____	C. V. +124 counts
		LOW	RANGE 3	C. V. -124 counts	_____	C. V. +124 counts
	C	HIGH	RANGE 3	-4 counts	_____	+36 counts
		LOW	RANGE 3	-5 counts	_____	+37 counts
	R	HIGH	RANGE 2	C. V. -124 counts	_____	C. V. +124 counts
		LOW	RANGE 2	C. V. -124 counts	_____	C. V. +124 counts
	L	HIGH	RANGE 2	-38 counts	_____	+8 counts
		LOW	RANGE 2	-40 counts	_____	+8 counts
4-13	Dissipation Factor Accuracy Check					
	C-D	HIGH	RANGE 3	C. V. x 0.99 - 11 counts	_____	C. V. x 1.01 + 11 counts
		LOW	RANGE 3	C. V. x 0.99 - 17 counts	_____	C. V. x 1.01 + 17 counts
4-16	Internal Bias Voltage Supply Check (OPT. 001)					
			0.0V	-0.005V	_____	0.005V
			0.1V	0.0948V	_____	0.1052V
			0.2V	0.1946V	_____	0.2054V
			0.5V	0.4940V	_____	0.5060V
			1.0V	0.9930V	_____	1.0070V
			2.0V	1.991V	_____	2.009V
			5.0V	4.985V	_____	5.015V
			10.0V	9.975V	_____	10.025V
			20.0V	19.955V	_____	20.05V
			39.9V	39.81V	_____	39.99V

*C. V.: CALIBRATED VALUE.

ADJUSTMENTS

5-23. A6 Zero Detector Zero Adjustment.

PURPOSE:

To adjust zero level of zero detector and gain of inverter (A6).

EQUIPMENT:

Test Fixture	HP 16038A
Oscilloscope	HP 180A/1801A/1821A

PROCEDURE:

a. Perform steps a through d in paragraph 5-22 except that TIME/DIV for oscilloscope is set to 20msec and VOLTS/DIV to 0.01V and connect oscilloscope CHANNEL A to 4271B A6TP2.

b. Set oscilloscope as follows:

TIME BASE	MIXED
TIME/DIV (MIXED)	1msec
SWEEP MODE	NORM
DELAYED TRIGGER	AUTO

c. Observe waveform at A6TP2. Adjust "C" OFFSET ADJ for flat waveform shown in Figure 5-12.

d. Adjust the DELAY (DIV) potentiometer slowly to about 4.5 to observe timing steps 6 thru 8 as shown in Figure 5-13. Adjust A6R52 for same DC level of steps 6 and 8 as shown in Figure 5-13 (S6 and S8 signals are adjusted to the same DC level).

e. Adjust A6R22 for "0.000pF" display.

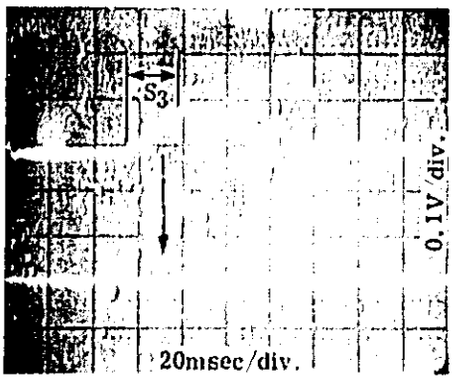


Figure 5-12. Waveform at A6TP2 (1).

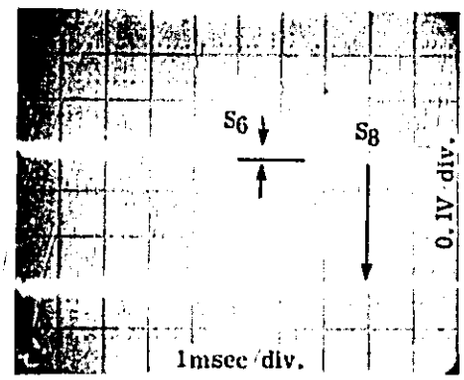


Figure 5-13. Waveform at A6TP2 (2).

SECTION V
ADJUSTMENT

5-1. INTRODUCTION.

5-2. This section provides the information needed to adjust the 4271B to its specifications (listed in Table 1-1). Prime purpose of adjustment is to return the instrument to its peak operating capabilities after repairs have been made. The instrument should be tested and adjusted when a part or component has been replaced. Adjustments sometimes restore an instrument to its normal operating conditions without the necessity of repairs. Adjustment procedures can also be performed periodically to maintain top operating performance Recommended adjustment schedule for the 4271B is every six months. All adjustable components referred to individual tests are summarized in Table 5-1. If proper performance cannot be achieved after adjustment procedures have been performed, refer to troubleshooting procedures beginning with paragraph 8-47.

Note

Before performing any adjustments, warm up instrument for more than 60 minutes to stabilize operating conditions.

5-3. SAFETY REQUIREMENTS.

5-4. Although the instrument has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to ensure safe operation and to keep the instrument in safe condition (see Sections II and III). Adjustments described in this section should be performed only be qualified service personnel.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE (GROUNDED) CONDUCTOR (INSIDE OR OUTSIDE THE INSTRUMENT) OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO MAKE THE INSTRUMENT DANGEROUS. INTENTIONAL INTERRUPTION IS PROHIBITED.

5-5. The opening of covers for removal of parts, except those to which access can be gained by hand, is likely to expose live parts. Accessible terminals many also be live.

5-6. Capacitors inside instrument may still be charged even if instrument has been disconnected from its source of supply.

WARNING

ADJUSTMENTS DESCRIBED HEREIN ARE PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT AFTER PROTECITVE COVERS HAVE BEEN REMOVED. ENERGY EXISTING AT MANY POINTS MAY, IF CONTACTED, RESULTS IN PERSONNEL INJURY.

5-7. EQUIPMENT REQUIRED.

5-8. The equipment needed to adjust the Model 4271B is listed in Table 4-1 (Page 4-0). This equipment should always be calibrated to satisfy its own specifications and those of the required characteristics. If the recommended model is not available, any instrument that has specifications equal to or better than required specifications may be substituted. Board extender to facilitate adjustments and repairs is housed inside instrument cabinet.

5-9. FACTORY SELECTED COMPONENTS.

5-10. Factory selected components can be recognized by an asterisk near the reference designator on the schematic diagrams in Section VIII (a nominal value is shown). Section VI, Replaceable Parts, lists the part number of the nominal value component. If the nominal value of the selected component is changed, the Manual Changes supplement, supplied with this manual, will list the change to update the manual. Table 5-2 lists all factory selected components with their nominal value ranges and their influence on instrument performance.

5-11. Adjustable components, with reference designators, are listed in Table 5-1. The table gives the name of the control to be adjusted and the purpose of its adjustment.

5-12. ADJUSTMENT RELATIONSHIPS.

5-13. The adjustment procedures, beginning with paragraph 5-15, should be performed in step sequence as they are interactive. Neglecting or changing procedures may make it impossible to gain best 4271B performance. Table 5-3 shows alignment procedures required when repairing the instrument (replacement of a component or board). The adjustments in Table 5-3 assume that no other adjustments were attempted prior to board or component replacement.

5-14. TOP COVER REMOVAL.

WARNING

WHEN TOP COVER IS REMOVED LIVE PARTS ARE EXPOSED.

a. Remove the 4 screws at left and right from top cover.

b. Pull top cover towards the rear and lift off.

ADJUSTMENTS

5-24. A7 Zero Detector Zero Adjustment.

PURPOSE:

To adjust zero level of zero detector and gain of invertor (A7).

EQUIPMENT:

Test Fixture	HP 16038A
Oscilloscope	HP 180A 1801A 1821A

PROCEDURE:

a. Perform steps a thru d in paragraph 5-22 except that TIME/DIV for oscilloscope is set to 20msec.

b. Adjust "G" OFFSET ADJ for as shown in Figure 5-14.

c. Set oscilloscope as follows:

TIME BASE	MIXED
TIME/DIV (MIXED)	1msec
SWEEP MODE	NORM
DELAYED TRIGGER	AUTO
VOLTS/DIV	0.01V

d. Adjust the DELAY (DIV) potentiometer slowly to about 6 to observe timing step 3 thru 5 as shown in Figure 5-15. Adjust A7R52 for same DC level of steps 3 and 5 as shown in Figure 5-15. S3 and S5 segments are adjusted to the same DC level.

e. Adjust A7R22 for "0.00μS" display.

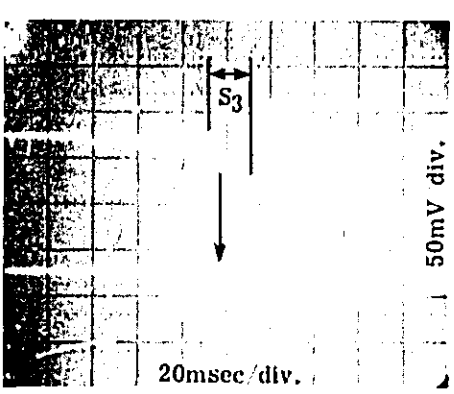


Figure 5-14. Waveform atA7TP2 (1).

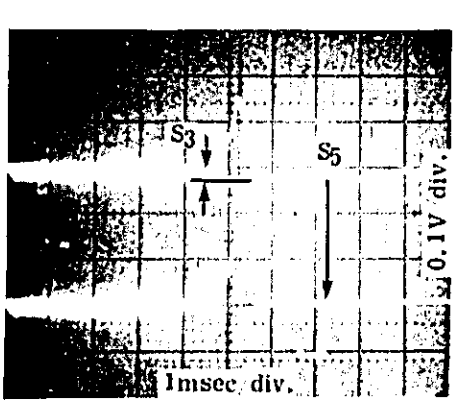


Figure 5-15. Waveform at A7TP2 (2).

Table 5-1. Adjustable Components.

Component	Paragraph	Name of Control	Purpose
A3R14	5-16	12V ADJ.	To adjust +12Vdc.
A4R9	5-17	OSC LEVEL	To adjust oscillator output level.
A5C2	5-21	φ ADJ. 0	To adjust reference signal phase.
A5C10		φ ADJ. 1	
A5C17		φ ADJ. 2	
A6R22	5-23	INVERTER GAIN ADJ.	To adjust gain of invertor.
A6R52		ZERO ADJ.	To adjust zero level of zero detector.
A6R30	5-22	ZERO ADJ.	To adjust zero offset of integrators.
A7R30		ZERO ADJ.	
A7R22	5-24	INVERTER GAIN ADJ.	To adjust gain of invertor.
A7R52		ZERO ADJ.	To adjust zero level of zero detector.
A8R9	5-18	R BAL 1	To adjust null detector balance of Modulator.
A8R10		R BAL 2	
A8R11		J BAL 1	
A8R12		J BAL 2	
A8R15	5-18 and 5-20	OFFSET 1	To adjust phase detector offset of Modulator.
A8R18		OFFSET 2	
A8C22	5-19	φ ADJ.	To set balancing time of bridge section to minimum.
A10R9	5-28	ADJ. 1	To adjust 10000 counts on C L and G R D displays.
A10R11		ADJ. 2	
A10C5		ADJ. 3	
A10C27	5-30	φ ADJ. 1	To adjust phase of Cs, Gs Amplifier.
A10C29		φ ADJ. 2	
A11C31	5-19	φ ADJ.	To set balancing time of bridge section to minimum.
A12R8	——	R COMPEN. ADJ.	To adjust voltage drop compensating circuit.
A12C4		C COMPEN. ADJ.	
A12R16	5-30	R of 10Ω ADJ.	To adjust range resistor.
A12C10		C of 10Ω ADJ.	
A12R12		R of 100Ω ADJ.	
A12C8		C of 100Ω ADJ.	
A12R18		R of 1kΩ ADJ.	
A12C11		C of 1kΩ ADJ.	
A12R21		R of 10kΩ ADJ.	
A12C13		C of 10kΩ ADJ.	
A21R32	5-33	0V ADJ.	To adjust internal DC bias voltage (OPT. 101).
A21R21		0.8V ADJ.	
A21R7		1V ADJ.	
A21R9		2V ADJ.	
A21R11		4V ADJ.	
A21R13		8V ADJ.	
A21R15		10V ADJ.	
A21R17		20V ADJ.	

ADJUSTMENTS

5-25. Dynamic Range Adjustment.

PURPOSE:

To adjust dynamic range of integrators (A6/A7).

EQUIPMENT:

Test Fixture	HP 16038A
Oscilloscope	HP 180A/1801A/1821A

PROCEDURE:

a. Perform steps a and b in paragraph 5-22 except connect oscilloscope CHANNEL A to 4271B A6TP2.

b. Set oscilloscope as follows:

VOLTS/DIV	0.5V
TIME/DIV	20msec
TRIGGER	EXT
	(use 10:1 probe)

c. Connect *18pF capacitor in parallel with **1pF capacitor and ***5.11kΩ to FIXTURE. (If ET-7902 is available, set position to 12).

* HP P/N: 0160-2322
** HP P/N: 0160-2355
*** HP P/N: 0757-0438

d. If peak-to-peak value of waveform is not within 15 - 17 volts or peak at right top of waveform cannot be recognized when changing VOLTS/DIV to 0.2V and POSITION of oscilloscope, increase A6R7* value for more amplitude or decrease A6R7* for less amplitude. (See Figure 5-16).

e. Change oscilloscope VOLTS/DIV to 0.5V.

f. Monitor waveform at A7TP2 with oscilloscope.

g. If peak-to-peak value of waveform is not within 15.4 - 17.5V or peak at right top of waveform cannot be recognized when changing VOLTS/DIV to 0.2V and POSITION of oscilloscope, increase A7R7* value for more amplitude or decrease A7R7* for less amplitude. (See Figure 5-16).

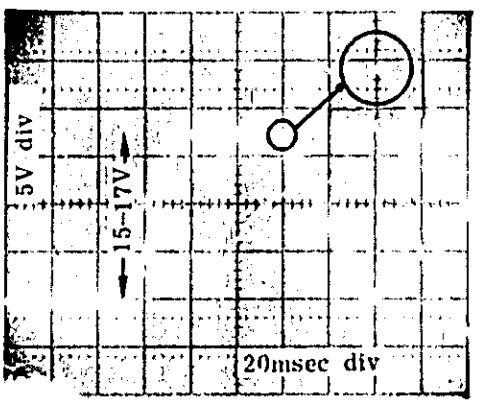


Figure 5-16. Dynamic Range Adjustment.

Table 5-2. Factory Selected Components (Sheet 1 of 2).

Component	Nominal Value Range	Effect on Performance
A4R13	HP P/N: 0757-0394, R:FXD 51.1Ω ▶ HP P/N: 0698-4386, R:FXD 59Ω HP P/N: 0757-0397, R:FXD 68.1Ω	To change oscillator LOW level. Refer to Paragraph 5-17.
A4C4	HP P/N: 0160-2200, C:FXD 43pF HP P/N: 0160-2201, C:FXD 51pF HP P/N: 0140-0205, C:FXD 62pF HP P/N: 0160-2202, C:FXD 75pF HP P/N: 0160-2203, C:FXD 91pF ▶ HP P/N: 0160-2204, C:FXD 100pF HP P/N: 0140-0194, C:FXD 110pF HP P/N: 0140-0195, C:FXD 130pF HP P/N: 0140-0196, C:FXD 150pF	To change oscillator level. If oscillator level is insufficient, use less capacitance; if excessive, use more capacitance. Refer to Paragraph 5-17.
A6R7	HP P/N: 0757-0464, R:FXD 90.9kΩ ▶ HP P/N: 0757-0465, R:FXD 100kΩ HP P/N: 0757-0466, R:FXD 110kΩ	To change level of integration. Refer to Paragraph 5-25.
A6C29	▶ BLANK HP P/N: 0160-2255, C:FXD 8.2pF HP P/N: 0160-2262, C:FXD 16pF HP P/N: 0160-2266, C:FXD 24pF	To make offset on L-R measurement. Refer to Paragraph 5-26.
A7R7	HP P/N: 0698-4498, R:FXD 53.6kΩ ▶ HP P/N: 0698-4501, R:FXD 59kΩ HP P/N: 0698-4502, R:FXD 64.9kΩ	To change level of integration. Refer to Paragraph 5-25.
A7C29	BLANK HP P/N: 0160-2255, C:FXD 8.2pF ▶ HP P/N: 0160-2262, C:FXD 16pF HP P/N: 0160-2266, C:FXD 24pF	To make offset on L-R measurement. Refer to Paragraph 5-26.
A8R47	▶ HP P/N: 0757-0420, R:FXD 750Ω HP P/N: 0757-0280, R:FXD 1kΩ	To make noise level lower. Refer to Paragraph 5-19.
A10R62	▶ BLANK HP P/N: 0683-1055, R:FXD 1MΩ HP P/N: 0683-5145, R:FXD 510kΩ HP P/N: 0683-3345, R:FXD 330kΩ	To make offset on C-G measurement. Refer to Paragraph 5-27.
A10C2	HP P/N: 0160-3502, C:FXD 0.3pF HP P/N: 0170-0031, C:FXD 0.39pF ▶ HP P/N: 0150-0021, C:FXD 0.47pF HP P/N: 0160-0046, C:FXD 0.68pF	To make offset on C-G measurement. Refer to Paragraph 5-27.
A10C37	HP P/N: 0150-0048, C:FXD 0.22pF ▶ HP P/N: 0150-0021, C:FXD 0.47pF HP P/N: 0150-0046, C:FXD 0.68pF HP P/N: 0150-0029, C:FXD 1.0pF HP P/N: 0150-0011, C:FXD 1.5pF	Refer to Paragraph 5-29.
A10C38	HP P/N: 0160-2239, C:FXD 1.8pF ▶ HP P/N: 0160-2246, C:FXD 3.6pF HP P/N: 0160-2251, C:FXD 5.6pF	To change phase of Gs. Refer to Paragraph 5-30.
A10C39	▶ BLANK HP P/N: 0160-2239, C:FXD 1.8pF HP P/N: 0160-2246, C:FXD 3.6pF	To change value of Cs. Refer to Paragraph 5-30.

ADJUSTMENTS

5-26. Zero Display Adjustment on L-R.

PURPOSE:

To adjust displays to zero on L-R measurement.

EQUIPMENT:

Test Fixture 16038A

PROCEDURE:

a. Set 4271B as follows:

FUNCTION ..... L-R
RANGE 1
TEST SIG LEVEL ..... HIGH
DUT ..... Short
(If ET-7902 is available, set to position 2).

b. Adjust L and R OFFSET ADJ controls on front panel for zero display (0 ±1 count).

c. Set RANGE to 3. Confirm that display of C L and G R D displays are within 0 ±2 counts. If not, perform steps d and e.

d. Set C L display to 0 ±2 counts by one or the other of below procedures:

L display can be decreased by one count by adding 8pF to A6C29*.

L display can be increased by one count by subtracting 8pF from A6C29*.

e. Set G R D display to 0 ±2 counts by one or the other of below procedures:

R display can be decreased by one count by adding 8pF to A7C29*.

R display can be increased by one count by subtracting 8pF from A7C29*.

Table 5-2. Factory Selected Components (Sheet 2 of 2).

Component	Nominal Value Range	Effect on Performance
A12R13	HP P N: 0757-0443, R:FXD 11kΩ ▶ HP P/N: 0757-0444, R:FXD 12.1kΩ HP P/N: 0757-0280, R:FXD 13.3kΩ	To change range resistor. Refer to Paragraph 5-30.
A12R15	HP P/N: 0698-3439, R:FXD 178Ω ▶ HP P/N: 0698-3440, R:FXD 196Ω HP P/N: 0698-3441, R:FXD 215Ω	
A12R19	HP P/N: 0698-4426, R:FXD 1.54kΩ ▶ HP P/N: 0698-3152, R:FXD 3.48kΩ HP P N: 0698-3155, R:FXD 4.64kΩ	
A12R22	HP P N: 0698-3437, R:FXD 147Ω ▶ HP P N: 0698-3439, R:FXD 178Ω HP P N: 0698-3440, R:FXD 196Ω	
A12C9	HP P N: 0160-2206, C:FXD 160pF ▶ HP P N: 0140-0197, C:FXD 180pF HP P N: 0140-0198, C:FXD 200pF	
A12C12	HP P N: 0160-2306, C:FXD 27pF ▶ HP P N: 0160-2199, C:FXD 30pF HP P N: 0160-2150, C:FXD 33pF	
A12R42	HP P N: 0757-0439, R:FXD 6.81kΩ ▶ HP P N: 0757-0440, R:FXD 7.5kΩ HP P N: 0757-0441, R:FXD 8.25kΩ	To change C-G OFFSET range. Refer to Paragraph 5-31.
A12R45	HP P N: 0757-0415, R:FXD 475Ω ▶ HP P N: 0757-0416, R:FXD 511Ω HP P N: 0757-0417, R:FXD 562Ω	
A12C16	HP P N: 0150-0059, C:FXD 3.3pF HP P N: 0160-2246, C:FXD 3.6pF ▶ HP P N: 0160-2247, C:FXD 3.9pF HP P N: 0160-2248, C:FXD 4.3pF	
A12C17	HP P N: 0160-2266, C:FXD 24pF ▶ HP P N: 0160-2306, C:FXD 27pF HP P N: 0160-2199, C:FXD 30pF	
A12R56	HP P N: 0757-0439, R:FXD 6.81kΩ ▶ HP P N: 0757-0440, R:FXD 7.5kΩ HP P N: 0757-0441, R:FXD 8.25kΩ	To change L-R OFFSET range. Refer to Paragraph 5-32.
A12R59	HP P N: 0757-0453, R:FXD 30.1kΩ ▶ HP P N: 0757-0454, R:FXD 33.2kΩ HP P N: 0757-0455, R:FXD 36.5kΩ	
A12C28	HP P N: 0150-0059, C:FXD 3.3pF HP P N: 0160-2246, C:FXD 3.6pF ▶ HP P N: 0160-2247, C:FXD 3.9pF HP P N: 0160-2248, C:FXD 4.3pF	

Note: Component marked (▶) in table is usually used.

ADJUSTMENTS

5-27. Zero Display Adjustment on C-G.

PURPOSE:

To adjust displays to zero on C-G measurement.

EQUIPMENT:

Test Fixture	16038A

PROCEDURE:

a. Set to 4271B as follows:

FUNCTION	C-G
RANGE	1
TEST LEVEL	HIGH
DUT	OPEN
(If ET-7902 is available, set to position 1)	

b. Adjust C and G OFFSET ADJ controls on front panel for zero display (0 ±1 count).

c. Set 4271B RANGE to 3. Confirm that C/L display is within 0 ±2 counts and G/R/D display within 0 ±2 counts. If not, perform steps d and e.

d. Set C/L display to 0 ±2 counts by one or the other of below procedures:

C display can be increased by one count by subtracting 0.1pF from A10C2*.

C display can be decreased by one count by adding 0.1pF to A10C2*.

e. Set G/R/D display to 0 ±2 counts by one or the other of below procedures:

G display can be increased by one count by removing 1MΩ in parallel with A10R62*.

G display can be decreased by one count by adding 1MΩ in parallel with A10R62*.

Table 5-3. Adjustment Requirements.

Assembly Repaired or Replaced	HP Part Number	Required Adjustments
A1	04271-66521	None
A2	04271-75001	
A3	04271-66505	Para. 5-16
A4	04271-77206	Para. 5-17
A5	04271-77207	Para. 5-21
A6	04271-77208	Para. 5-21 thru 5-23 and 5-25 and 5-26
A7	04271-77209	Para. 5-21 thru 5-23 and 5-25 and 5-26
A8	04271-77210	Para. 5-18 thru 5-20
A9	04271-77211	Para. 5-17
A10	04271-77212	Para. 5-21 thru 5-32
A11	04271-77213	Para. 5-18 thru 5-20
A12	04271-77214	Para. 5-30 thru 5-32
A13	04271-66525	None
A14	04271-66526	
A15	04271-66527	
A16	04271-66528	
A17	04271-66529	
A18	04271-66530	
A19	04271-66532	
A20	04271-60001	
A21 (OPT. 001)	04271-77227	Para. 5-33
A23 (OPT. 002)	04271-77229	None
A24 (OPT. 003)	04271-77230	
A25 (OPT. 004)	04271-77231	
A26 (OPT. 004)	04271-77232	
A31 (OPT. 101)	04271-66551	
A32 (OPT. 101)	04271-66552	
A33 (OPT. 101.	04271-66553	
A34 (OPT. 101)	04271-66554	
A35 (OPT's 002, 003, 004)	04271-77238	

ADJUSTMENTS

5-28. 10000 Counts Adjustment.

PURPOSE:

To adjust 10000 counts on C/L and G/R/D displays.

EQUIPMENT:

Electronic Tool ..... HP ET-1467

PROCEDURE:

a. Set 4271B and ET-1467 as in Figure 5-17.

b. Set 4271B controls:

FUNCTION ..... C-G
RANGE 2
TEST LEVEL ..... HIGH
TRIGGER ..... INT

c. Adjust A10R9 (5kΩ) for 10000 ±3 counts on G display.

d. Adjust A10R11 (50Ω) for 0 ±4 counts on C display.

e. Set FUNCTION to L-R and RANGE to 3.

f. Confirm that R display is within 10000 ±4 counts.

g. Confirm that L display is within 0 ±5 counts.

Note

If not, adjust A10C5 for 10000 ±4 counts on R display.

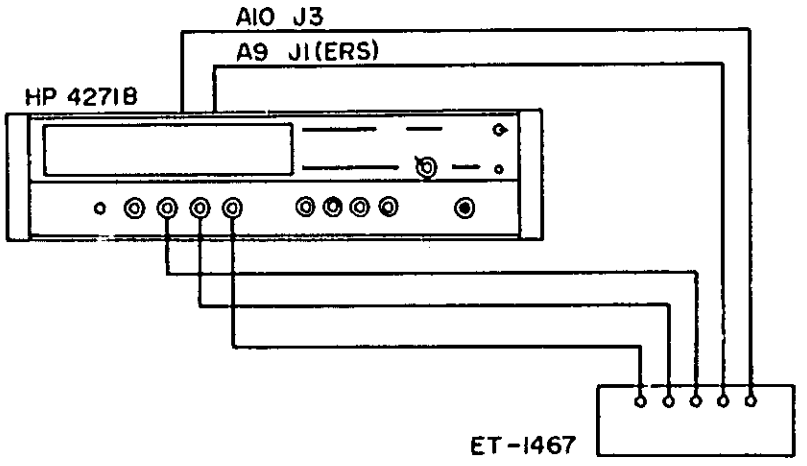


Figure 5-17. HP 4271B Connections to ET-1467.

5-15. ADJUSTMENTS.

5-16. DC Power Supply Adjustment.

PURPOSE:

This adjustment procedure sets +12Vdc (A3).

EQUIPMENT:

DC Voltmeter ..... HP 3400A

PROCEDURE:

a. Remove top cover of 4271B.

b. Connect a dc voltmeter to TP2 and A GND on A3 board, as shown in Figure 5-1.

c. Adjust A3R14 for +11.95Vdc to +12.05V.

d. Disconnect dc voltmeter.

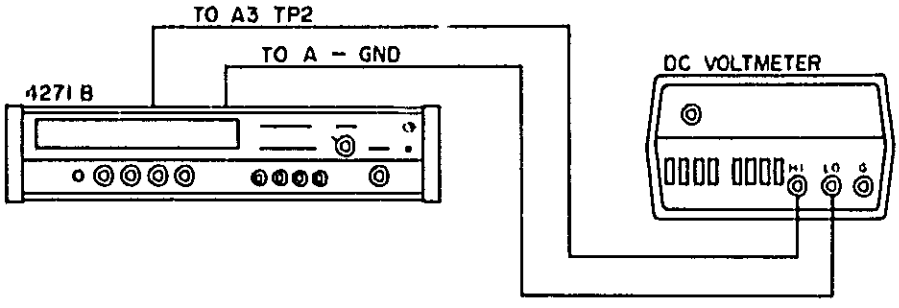


Figure 5-1. Power Supply Adjustment.

5-29. D Error Adjustment.

PURPOSE:

To Adjust D error on C-D measurement.

EQUIPMENT:

Test Fixture .....HP 16038A

PROCEDURE:

a. Remove ET-1467 and operate 4271B with top, bottom and side covers on for at least half an hour.

b. Set 4271B as follows:

FUNCTION ..... C-D
RANGE 3
TEST SIG LEVEL ..... HIGH
TRIGGER ..... INT

c. Connect *1000pF capacitor to FIXTURE (if ET-7902 is available, set position to 9).

* HP P N: 0160-2218

d. Read C and D displays.

e. Change 4271B TEST SIG LEVEL to LOW and read C and D displays.

f. Difference between D readings for HIGH and LOW TEST SIG LEVELS should be within 5 counts. If not, perform step g.

g. D display on LOW TEST LEVEL can be increased by approximately 3 counts by adding 0.2pF to A10C37*.

D display on LOW can be decreased by about 1 counts by subracting 0.2pF from A10C37*.

5-17. Oscillator Level Adjustment.

PURPOSE:

This adjustment procedure sets oscillator output level (A4).

EQUIPMENT:

AC Voltmeter .....HP 400E

PROCEDURE:

a. Connect AC Voltmeter to 4271B as shown in Figure 5-2.

b. Set 4271B controls as follows:

FUNCTION .....C-G
RANGE 2
TEST SIG LEVEL .....HIGH
TRIGGER .....INT

c. Adjust A4R9 OSC. LEVEL for 490 - 510mVrms.

d. If adjustment cannot be made with A4R9, replace A4C4* with different value.

e. Set TEST SIG LEVEL to LOW. AC Voltmeter should read 19 - 21mVrms.

f. If not, add 10Ω to A4R13* to increase by 3mVrms, or subtract 10Ω to decrease by 3mVrms.

g. Disconnect AC Voltmeter.

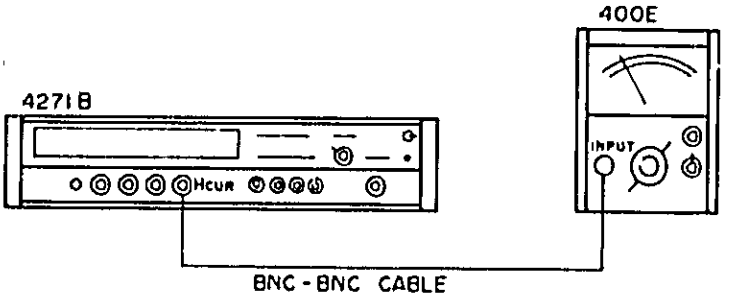


Figure 5-2. Oscillator Adjustment.

5-30. Range Calibration.

PURPOSE:

To adjust range resister and phase of Cs, Gs Amplifier.

EQUIPMENT:

Test Fixture	HP 16021A
DUT	GR-900-WN GR-900-W100 GR-1405-B, GR-1405-E GR-1406-A, GR-1406-D GR-1407-D

PROCEDURE:

a. Warm up 4271B for more than one hour (with top and bottom covers on). Only during actual adjustment time should top cover be removed. Adjustment should be performed with internal shield plate in place.

b. Set 4271B controls as follows:

FUNCTION	C-G
RANGE	1
TEST LEVEL	HIGH
TRIGGER	INT
DUT	GR-1405-E

c. Connect GR-1405-E to HP 16021A and adjust C OFFSET ADJ to calibrated value of GR-1405-E on C display and G OFFSET ADJ for 0μS on G display.

d. Set FUNCTION to L-R and connect GR-900-WN to HP 16021A and adjust R OFFSET ADJ for 0Ω and L OFFSET ADJ for 0nH.

e. Set RANGE to 2 and connect GR-900-W100. Adjust R of 100Ω ADJ on A12 for calibrated values of GR-900-W100 on R display and # of 100Ω ADJ on L display. If not, change value of A12R13*.

f. Set RANGE to 3 and FUNCTION to C-G and connect GR-1406-A. Adjust A10C29 for calibrated value of GR-1406-A on C display. If not, change value of A10C39*. Adjust A10C27 for zero (0) on G display. If not, change value of A10C38*.

g. Set RANGE to 4 and connect GR-1407-D. Adjust R of 10Ω ADJ on A12 for calibrated value of GR-1407-D on C display and # of 10Ω ADJ on G display. If not, change values of A12R15* and A12C9*.

h. Set RANGE to 1 and connect GR-1405-B. Adjust R of 10kΩ ADJ on A12 for calibrated values of GR-1405-B on C display and # of 10kΩ on G display. If not, change values of A12R22* and A12C12*.

i. Set RANGE to 2 and connect GR-1406-D. Adjust R of 1kΩ ADJ on A12 for calibrated values of GR-1406-D on C display and # of 1kΩ ADJ on G display. If not, change value of A12R19*.

5-18. Null Detector Balance Adjustment.

PURPOSE:

To adjust null detector balance of Modulator (A8).

EQUIPMENT:

Test Fixture	HP 16038A
Oscilloscope	HP 180A/1801A/1821A

PROCEDURE:

a. Remove shield plate covering A11 and A12 boards.

b. Connect as shown in Figure 5-3.

c. Set 4271B controls as follows:

FUNCTION	C-G
RANGE	1
TEST SIG LEVEL	HIGH
TRIGGER	INT

d. Do not connect anything to Test Fixture (Open). (If ET-7002 is available, set to position 1).

e. Oscilloscope setting:

VOLTS DIV	0.005V
TIME DIV	0.2 μsec
TRIGGER	EXT (use 10:1 probe)
INPUT	AC

f. Observe signal at A11TP4 and adjust A8R15 and A8R16 for waveform (shown in Figure 5-4) for minimum amplitude.

g. Observe waveform at A8TP2 (A8Q1 Source) and adjust A8R9 for waveform shown in in Figure 5-5.

h. Observe waveform at A8TP3 (A8Q2 Source) and adjust for that shown in Figure 5-5 with A8R10.

i. Observe waveform at A8TP4 (A8Q3 Source) and adjust for that shown in Figure 5-5 with A8R11.

j. Observe waveform at A8TP5 (A8Q4 Source) and adjust for that shown in Figure 5-5 with A8R12.

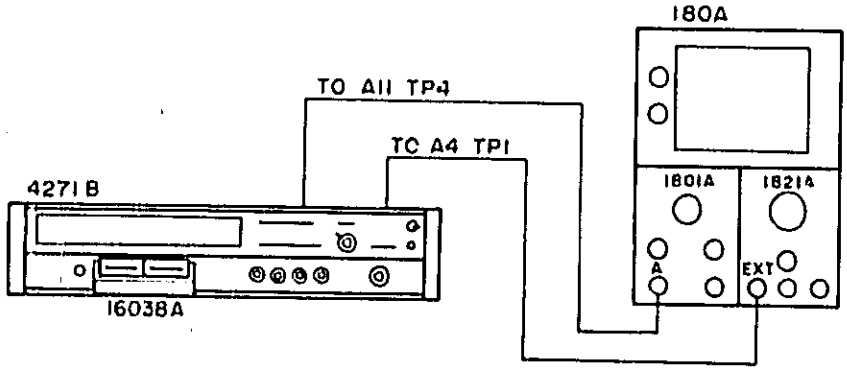


Figure 5-3. Null Detector Adjustment.

5-31. C-G OFFSET Counts Adjustment.

PURPOSE:

To adjust C-G OFFSET ADJ.

EQUIPMENT:

BNC-BNC cable ..... HP 10502A x 2

PROCEDURE:

a. Set 4271B controls as follows:

FUNCTION ..... C-G
RANGE 1
TEST SIG LEVEL ..... HIGH
TRIGGER ..... INT
RATE ..... FULL CW

b. Connect Lcur to Lpor terminal with BNC-BNC cable. Connect Hcur to Hpor terminal with BNC-BNC cable.

c. Set C OFFSET ADJ full cw, G OFFSET ADJ full cw, and read C display. Then set G OFFSET ADJ full ccw and read C display. Both readings of C display should be more than +50 counts. If not, increase A12C16*.

d. Set G OFFSET ADJ full cw, C OFFSET ADJ full cw, and read G display. Then set G OFFSET ADJ full ccw and read display. Both readings of G should be more than +8 counts. If not, increase A12C17*.

e. Set G OFFSET ADJ full ccw, C OFFSET ADJ full cw and read G display. Then set C OFFSET ADJ full ccw and read G display. Both readings of G should be less than -102 counts. If not, decrease A12R45*.

f. Set RANGE to 2, C OFFSET ADJ full ccw, G OFFSET ADJ full cw and read C display. Then set G OFFSET ADJ full ccw and read C display. Both readings of C should be less than -105 counts. If not, decrease A12R42*.

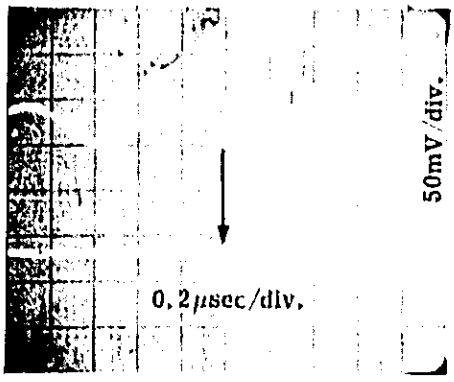


Figure 5-4. Waveform at A11TP4.

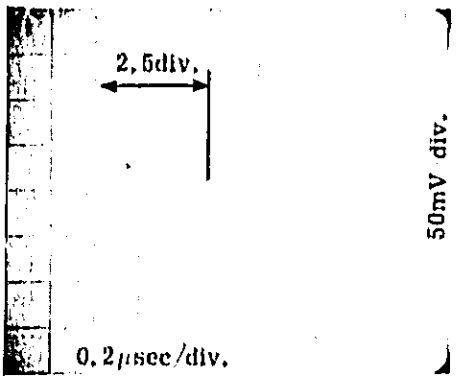


Figure 5-5. Waveform at A8TP2 thru A8TP5.

5-19. Balancing Time Adjustment.

PURPOSE:

These adjustments set balancing time of bridge section to minimum (less than 1.5msec).

EQUIPMENT:

Test Fixture	HP 16038A
Oscilloscope	HP 180A 1801A 1821A

PROCEDURE:

a. Connect as shown in Figure 5-3.

b. Set 4271B controls as follows:

FUNCTION	L-R
RANGE	4
TEST SIG LEVEL	HIGH
TRIGGER	INT

c. Set oscilloscope controls as follows:

VOLTS DIV	0.02V
TIME DIV (MAIN)	50msec
TIME DIV (MIXED)	1msec
TRIGGER	EXT
	(with sync from A13TP1)
	(use 10:1 probe)

ADJUSTMENTS

5-32. L-R OFFSET Counts Adjustment.

PURPOSE:

To adjust L-R OFFSET ADJ.

EQUIPMENT:

BNC-BNC cable	HP 10502A x 4
BNC Adapter	HP P N:1250-0781 x 2
	HP P N:1250-0081

PROCEDURE:

a. Set 4271B controls as follows:

FUNCTION	L-R
RANGE	1
TEST SIG LEVEL	HIGH
TRIGGER	INT
RATE	FULL CW

b. Connect Lcur, Lpot, Hcur and Hpot terminals as shown in Figure 5-18.

c. Set L OFFSET ADJ full cw, R OFFSET ADJ full cw and read L display. Then set R OFFSET ADJ full ccw and read L display. Both readings of L should be more than +15 counts. If not, increase A12C28*.

d. Set R OFFSET ADJ full cw, L OFFSET ADJ full cw and read R display. Then set L OFFSET ADJ full ccw and read R display. Both readings of R should be more than +15 counts. If not, decrease A12R59*.

e. Set R OFFSET ADJ full ccw, L OFFSET ADJ full cw and read R display. Then set L OFFSET ADJ full ccw and read R display. Both readings of R should be less than -105 counts. If not, decrease A12R56*.

f. Set RANGE to 2, L OFFSET full ccw, R OFFSET full cw and read L display. Then set R OFFSET ADJ full ccw and read L display. Both readings of L should be less than -105 counts. If not, decrease A12R56*.

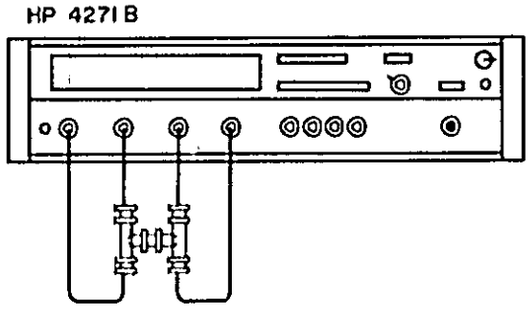


Figure 5-18. L-R OFFSET Counts Adjustment.

d. Connect DUT constructed as follows to Fixture:

*200μH in series with **1.05kΩ.

* HP P N: 9140-0237
** HP P N: 0698-5419

(If ET-7902 is available, set to position 5).

e. Observe waveform at A11TP4. Adjust A11C31 and A8C22 for minimum balancing time less than 1.5msec (see Figure 5-6).

Note

Balancing adjustment can only be done when UNBAL lamp does not turn on and off and no other annunciator is lit.

f. Connect a *1000μH inductance in series with **470μH and another 470μH to TEST FIXTURE (If ET-7902 is available, set to position 6). Observe waveform at A11TP4. Adjust A11C31 so minimum balancing time is less than 1.5msec (see Figure 5-6).

* HP P N: 9140-0137
** HP P N: 9100-1647

Note

If not, adjust A8C22 slightly.

g. Connect a *1940μH inductance in series with a **19.6kΩ resistor TEST FIXTURE (If ET-7902 is available, set to position 7). Adjust A8C22 so minimum balancing time is less than 1.5msec (see Figure 5-6).

* Use inductance of step f in series.
** HP P N: 0698-3157.

h. Connect *19.6kΩ to FIXTURE (If ET-7902 is available, set to position 8). Confirm that balancing time is less than 1.5msec.

* HP P N: 0698-3157

i. Connect short bar (0Ω) to FIXTURE (If ET-7902 is available, set to position 2). Confirm that noise level is less than 200mVp-p when TEST SIG LEVEL is HIGH, and 250mVp-p when TEST SIG LEVEL is LOW.

Note

If not, change A8R47 (750Ω*) to 1kΩ**, and return to step f.

* HP P N: 0757-0420
** HP P N: 0757-0280

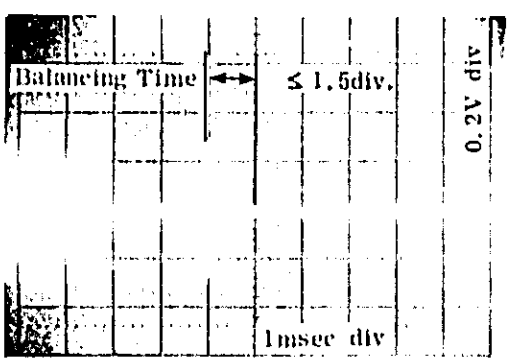


Figure 5-6. Balancing Time Adjustment.

5-33. DC Bias Voltage Adjustment (OPT. 001).

PURPOSE:

To adjust internal DC bias voltage (OPT. 001).

EQUIPMENT:

Test Fixture	HP 16023A
DC Voltmeter	HP 3490A

PROCEDURE:

a. Connect DC voltmeter to MONITOR on rear panel.

b. Connect Model 16023A BIAS CONTROLLER or other instrument which satisfies specifications of 16023A to DC BIAS CONTROL on rear panel.

c. Set BIAS VTG on rear panel to INT.

d. 0V adjustment. Set BIAS CONTROLLER to 00.0V. Adjust 0V potentiometer on A21 or 0.00V (±5mV).

e. 0.8V adjustment. Set BIAS CONTROLLER to 0.8V. Adjust 0.8V potentiometer on A21 for 0.8V (±6mV).

f. 1.0V adjustment. Set BIAS CONTROLLER to 1.0V. Adjust 1.0V potentiometer on A21 for 1.0V (±7mV).

g. 2.0V adjustment. Set BIAS CONTROLLER to 2.0V. Adjust 2.0V potentiometer on A21 for 2.0V (±9mV).

h. 4.0V adjustment. Set BIAS CONTROLLER to 4.0V. Adjust 4.0V potentiometer on A21 for 4.0V (±10mV).

i. 8.0V adjustment. Set BIAS CONTROLLER to 8.0V. Adjust 8.0V potentiometer on A21 for 8.0V (±21mV).

j. 10.0V adjustment. Set BIAS CONTROLLER to 10.0V. Adjust 10.0V potentiometer on A21 for 10.0V (±25mV).

k. 20.0V adjustment. Set BIAS CONTROLLER to 20.0V. Adjust 20.0V potentiometer on A21 for 20.0V (±45mV).

ADJUSTMENTS

5-20. Modulator Offset Adjustment.

PURPOSE:

To adjust phase detector offset of Modulator (A8).

EAUIPMENT:

Test Fixture	HP 16038A
Selective Voltmeter	HP 312B

PROCEDURE:

a. Connect as shown in Figure 5-7.

b. Set 4271B as follows:

FUNCTION	C-G
RANGE	1
TEST SIG LEVEL	HIGH
TRIGGER	INT

c. Set Selective Voltmeter (HP 312B as follows):

INPUT MODE	BRIDGED 50Ω
BAL UNBAL	UNBAL
FREQUENCY RANGE	0
BAND WIDTH	200Hz
RECEIVER MODE	AM
REFERENCE LEVEL	-10dBm

d. Do not connect anything to FIXTURE (if ET-7902 is available, set to position 1 (0pF)).

e. Tune HP 312B for maximum deflection on meter at 1MHz.

f. Adjust A8R15 and A8R18 until indicated value of HP 312B is less than 200μVrms.

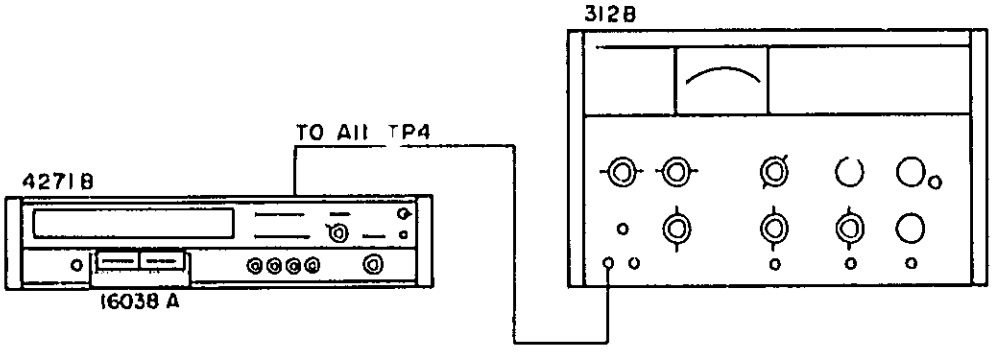


Figure 5-7. Modulator Offset Adjustment.

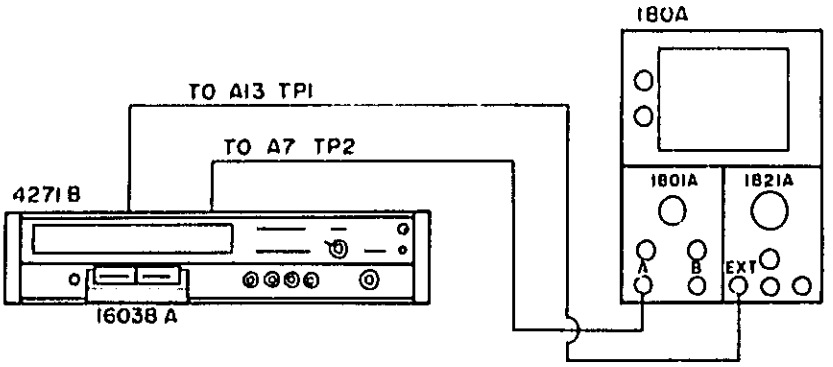


Figure 5-8. Reference Phase Adjustment.

ADJUSTMENTS

5-21. Reference Phase Adjustment.

PURPOSE:

To adjust reference signal phase (A5).

EQUIPMENT:

Test Fixture	HP 16038A
Oscilloscope	HP 180A 1801A 1821A

PROCEDURE:

a. Connect as shown in Figure 5-8.

b. Set 4271B controls as follows:

FUNCTION	C-G
RANGE	3
TEST SIG LEVEL	LOW
TRIGGER	INT

c. Set oscilloscope setting as follows:

VOLTS DIV	0.005V
TIME DIV	20msec
TRIGGER	EXT
	(use 10:1 probe)

d. Connect *1000pF capacitor to FIXTURE (if ET-7002 is available, set to position 9).

* HP P N: 0160-2218

e. Adjust A5C10 so waveform at A7TP2 matches that shown in Figure 5-9.

f. Set 4271B TEST SIG LEVEL to HIGH.

g. Do same adjustment as in step e with A5C2 (not A5C10).

h. Connect *100Ω resistor instead of 1000pF. (If ET-7002 is available, set to position 10).

* HP P N: 0757-0401

i. Observe waveform A6TP2. Adjust A5C17 for flat waveform shown in Figure 5-10.

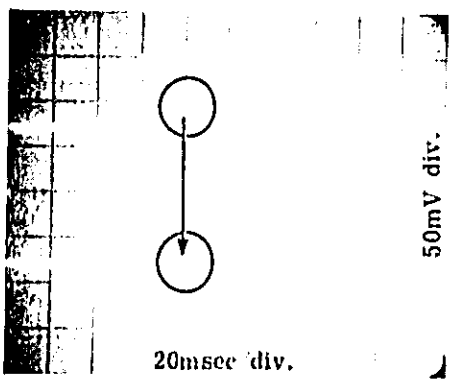


Figure 5-9. Waveform at A7TP2.

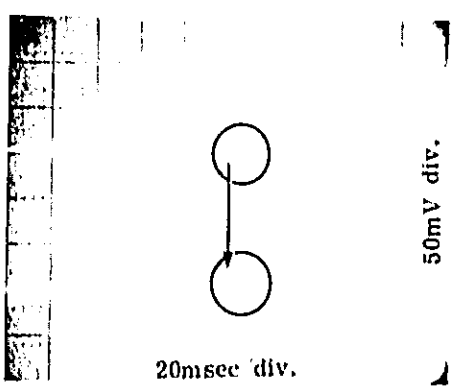


Figure 5-10. Waveform at A6TP2.

ADJUSTMENTS

5-22. Integrator Offset Adjustment.

PURPOSE:

To adjust zero offset of integrators (A6/A7).

EQUIPMENT:

Test Fixture	HP 16033A
Oscilloscope	HP 180A/1801A/1821A

PROCEDURE:

a. Connect as shown in Figure 5-8.

b. Set 4271B controls as follows:

FUNCTION	C-G
RANGE	1
TEST SIG LEVEL	HIGH
TRIGGER	INT

c. Set oscilloscope settings as follows:

VOLTS DIV	0.035V
TIME/DIV	10msec
TRIGGER	EXT
INPUT	DC
	(use 10:1 probe)

d. Do not connect anything to FIXTURE (if ET-7902 is available, set to position 1).

e. Adjust A7R30 for waveform at A7TP2 shown in Figure 5-11.

f. Observe waveform at A6TP2. Adjust A6R30 as in step e.

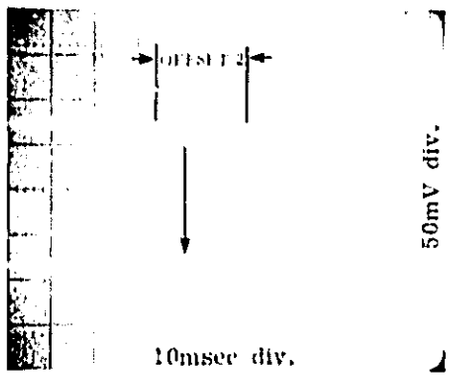


Figure 5-11. Integrator Offset Adjustment.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list and throughout the manual. Table 6-3 lists all replaceable parts in reference designator order. Table 6-2 contains the names and addresses that correspond to the manufacturer's code numbers.

6-3. ABBREVIATIONS.

6-4. Table 6-1 lists abbreviations used in parts list, schematics and throughout the manual. In some cases, two forms of abbreviations are used, one in all capital letters, and one in partial capitals or no capitals. This occurs because the abbreviations in parts list are always all capitals. However, in the schematics and in other parts of the manual, other abbreviation forms with both lower case and upper case letters are used.

6-5. REPLACEABLE PARTS LIST.

6-6. Table 6-3 is a list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components in alphanumerical order by reference designation.

b. Chassis-mounted parts in alphanumerical order by reference designation.

c. Miscellaneous parts.

d. Illustrated parts breakdowns, if appropriate.

The information for each part includes:

a. The Hewlett-Packard part number.

b. The total quantity (Qty) in the instrument.

Table 6-1. List of Reference Designators and Abbreviations

REFERENCE DESIGNATORS

A	assembly	E	misc electronic part	P	plug	U	integrated circuit
B	motor	F	fuse	Q	transistor	V	vacuum tube, neon bulb, photocell, etc
BT	battery	FL	filter	R	resistor		
C	capacitor	J	jack	RT	thermistor	VR	voltage regulator
CP	coupler	K	relay	S	switch	W	cable
CR	diode	L	inductor	T	transformer	X	socket
DL	delay line	M	meter	TB	terminal board	Y	crystal
DS	device signaling (lamp)	MP	mechanical part	TP	test point		

ABBREVIATIONS

A	ampere	H	henries	NPN	negative-positive-negative	PWV	peak working voltage
AFC	automatic frequency control	HEX	hexagonal	NRFR	not recommended for field replacement		
AMPL	amplifier	HG	mercury				
BFO	beat frequency oscillator	HR	hour(s)	NSR	not separately replaceable	S-B	slow-blow
BE CU	beryllium copper	Hz	hertz			SCR	screw
BH	binder head	IF	intermediate freq			SE	selenium
BP	bandpass	IMPG	impregnated			SECT	section(s)
BRS	brass	INCD	incandescent	OBD	order by description	SEMICON	semiconductor
BWO	backward wave oscillator	INCL	include(s)	OH	oval head	SI	silicon
CCW	counter-clockwise	INS	insulation(ed)	OX	oxide	SIL	silver
CER	ceramic	INT	internal			SL	slide
CMO	cabinet mount only	k	kilo 10^3	P	peak	SPG	spring
COEF	coefficient	LH	left hand	PC	printed circuit	SPL	special
COM	common	LIN	linear taper	p	pico 10^{-12}	SST	stainless steel
COMP	composition	LK WASH	lock washer	PH BRZ	phosphor bronze	SR	split ring
COMPL	complete	LOG	logarithmic taper	PHL	Phillips	STL	steel
CONN	connector	LPF	low pass filter	PIV	peak inverse voltage	TA	tantalum
CP	cadmium plate			PNP	positive-negative-positive	TD	time delay
CRT	cathode-ray tube	m	milli 10^{-3}			TGL	toggle
CW	clockwise	M	meg 10^6	P O	part of	THD	thread
DEPC	deposited carbon	MET FILM	metal film	POLY	polystyrene	TI	titanium
DR	drive	MET OX	metallic oxide	PORC	porcelain	TOL	tolerance
ELECT	electrolytic	MFR	manufacturer	POS	position(s)	TRIM	trimmer
ENCAP	encapsulated	MINAT	miniature	POT	potentiometer	TWT	traveling wave tube
EXT	external	MOM	momentary	PP	peak-to-peak		
F	farads	MTG	mounting	PT	pint	μ	micro 10^{-6}
f	femto 10^{-15}	MY	mylar	PWV	peak working voltage	VAR	variable
FH	flat head	n	nano 10^{-9}			VDCW	dc working volts
FIL H	fillister head	N C	normally closed			W	with
FXD	fixed	NE	neon	RECT	rectifier	W	watts
G	giga 10^9	NI PL	nickel plate	RF	radio frequency	WIV	working inverse voltage
GE	germanium	N O	normally open	RH	round head or right hand		
GL	glass	NPO	negative positive zero (zero temperature coefficient)	RMO	rack mount only	WW	wirewound
GRD	grounded			RMS	root-mean-square	W O	without

0001-9700

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A10CR6	1902-3149		DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	28480	1902-3149
A10CR7	1902-3149		DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	28480	1902-3149
A10CR8	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=+.009%	28480	1902-0041
A10CR9	5080-3039	4	DIODE	28480	5080-3039
A10CR10	5080-3039		DIODE	28480	5080-3039
A10J1	1250-0257		CONNECTOR-RF BNC M PC 50-OHM	28480	1250-0257
A10J2	1250-0257		CONNECTOR-RF BNC M PC 50-OHM	28480	1250-0257
A10J3	1250-0257		CONNECTOR-RF BNC M PC 50-OHM	28480	1250-0257
A10K1	0493-0875	1	RELAY	28480	0493-0875
A10L1	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L2	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L3	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L5	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L6	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L7	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L8	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L9	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L10	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L11	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L12	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L13	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L14	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10L15	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-OHM	28480	9140-0129
A10Q1	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q2	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q3	1854-0854		TRANSISTOR NPN SI		
A10Q4	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q5	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A10Q6	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q7	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q8	1854-0854		TRANSISTOR NPN SI		
A10Q9	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q10	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A10Q11	1854-0854		TRANSISTOR NPN SI		
A10Q12	1855-0081		TRANSISTOR J-FET N-CHAN D-MODE SI	01295	2N5245
A10Q13	1854-0854		TRANSISTOR NPN SI		
A10Q14	1855-0081		TRANSISTOR J-FET N-CHAN D-MODE SI	01295	2N5245
A10Q15	1854-0854		TRANSISTOR NPN SI		
A10Q16	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q17	1854-0854		TRANSISTOR NPN SI		
A10Q18	1854-0854		TRANSISTOR NPN SI		
A10Q19	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q20	1854-0854		TRANSISTOR NPN SI		
A10Q21	1854-0039		TRANSISTOR NPN 2N3053B SI TO-39 PD=1W	04713	2N3053
A10Q22	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q23	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q24	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q25	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q26	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q27	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q28	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q29	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A10Q30	1853-0012		TRANSISTOR PNP 2N2904A SI TO-39 PD=600MW	01295	2N2904A
A10R1	0683-2735		RESISTOR 27K 5% .25W FC TC=+800/+800	01121	CB2735
A10R2	0683-2735		RESISTOR 27K 5% .25W FC TC=+800/+800	01121	CB2735
A10R3	0683-6825	5	RESISTOR 6.8K 5% .25W FC TC=+800/+700	01121	CB6825
A10R4	0683-3925	17	RESISTOR 3.9K 5% .25W FC TC=+800/+700	01121	CB3925
A10R5	0683-3925		RESISTOR 3.9K 5% .25W FC TC=+800/+700	01121	CB3925
A10R6	0683-4735	2	RESISTOR 47K 5% .25W FC TC=+800/+800	01121	CB4735
A10R7	0683-1235		RESISTOR 12K 5% .25W FC TC=+800/+800	01121	CB1235
A10R8	0698-3155		RESISTOR 4.64K 1% .125W F TC=0++100	24546	C4-1/8-T0-4641-F
A10R9	2100-1233	2	RESISTOR, VAR PLN 5K OHM 10% LIN 1/2W	28480	2100-1233
A10R10	0683-1045		RESISTOR 100K 5% .25W FC TC=+800/+800	01121	CB1045
A10R11	2100-2520	3	RESISTOR-TRMR 50 20% C SIDE-ADJ 1-TRN	30983	ET50X500
A10R12	0698-3432	1	RESISTOR 86.1 1% .125W F TC=0++100	03888	PME55-1/8-T0-86R1-F
A10R13	0683-2735		RESISTOR 27K 5% .25W FC TC=+800/+800	01121	CB2735
A10R14	0683-2735		RESISTOR 27K 5% .25W FC TC=+800/+800	01121	CB2735
A10R15	0683-6825		RESISTOR 6.8K 5% .25W FC TC=+800/+700	01121	CB6825
A10R16	0683-3925		RESISTOR 3.9K 5% .25W FC TC=+800/+700	01121	CB3925
A10R17	0683-3925		RESISTOR 3.9K 5% .25W FC TC=+800/+700	01121	CB3925
A10R18	0683-4735		RESISTOR 47K 5% .25W FC TC=+800/+800	01121	CB4735
A10R19	0683-1235		RESISTOR 12K 5% .25W FC TC=+800/+800	01121	CB1235
A10R21	0683-1045		RESISTOR 100K 5% .25W FC TC=+800/+800	01121	CB1045

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A10R22	0683-1835		RESISTOR 18K 5% .25W FC TC=-400/+800	01121	CB1835
A10R23	0683-1235		RESISTOR 12K 5% .25W FC TC=-400/+800	01121	CB1235
A10R24	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A10R25	0683-1235		RESISTOR 12K 5% .25W FC TC=-400/+800	01121	CB1235
A10R26	0683-1025	11	RESISTOR 1.0K 5% .25W FC TC=-400/+700	01121	CB1025
A10R27	0683-2735		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A10R29	0698-3150		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A10R30	0683-1635	1	RESISTOR 16K 5% .25W FC TC=-400/+800	01121	CB1635
A10R31	0683-5135	1	RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A10R32	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A10R33	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A10R34	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A10R35	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A10R36	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A10R37	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A10R38	0698-3150		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A10R39	0683-2415		RESISTOR 240 5% .25W FC TC=-400/+800	01121	CB2415
A10R40	0683-6225		RESISTOR 6.2K 5% .25W FC TC=-400/+700	01121	CB6225
A10R41	0683-2425		RESISTOR 2.4K 5% .25W FC TC=-400/+700	01121	CB2425
A10R42	0683-5615	1	RESISTOR 560 5% .25W FC TC=-400/+800	01121	CB5615
A10R43	0683-6225		RESISTOR 6.2K 5% .25W FC TC=-400/+700	01121	CB6225
A10R45	0683-2735		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A10R46	0698-00..		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A10R47	0683-2735		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A10R48	0698-0084		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A10R49	0683-6225		RESISTOR 6.2K 5% .25W FC TC=-400/+700	01121	CB6225
A10R50	0683-2735		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A10R51	0698-0084		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A10R52	0683-2735		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A10R53	0698-0084		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A10R54	0698-2192	2	RESISTOR MET FLM 91.17 OHM 0.1% 1/8W	28480	0698-2192
A10R55	0698-2194	1	RESISTOR MET FLM 900 OHM 0.1% 1/8W	28480	0698-2194
A10R56	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A10R57	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+800	01121	CB5115
A10R58	0683-6805	1	RESISTOR 68 5% .25W FC TC=-400/+500	01121	CB6805
A10R59	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A10R60	0683-8215		RESISTOR 820 5% .25W FC TC=-400/+800	01121	CB8215
A10R61	0698-0084		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A10R62*					
A10T1	9100-0823		TRANSFORMER:(TOK:13381) 18111	28480	9100-0823
A10T2	9100-0823		TRANSFORMER:(TOK:13381) 18111	28480	9100-0823
A10T3	9100-0822	1	TRANSFORMER:PULSE(113077)	28480	9100-0822
A10T4	9100-0820		TRANSFORMER:PULSE	28480	9100-0820
A10T5	9100-0820		TRANSFORMER:PULSE	28480	9100-0820
A10T6	9100-0820		TRANSFORMER:PULSE	28480	9100-0820
A10U1	1820-0308		IC DIFF AMPL T0-99	01928	CA3028A
	04271-10001	1	SHIELD	28480	04271-10001
	04271-10002	1	SHIELD	28480	04271-10002
A11	04271-77213	1	NULL DETECTOR ASSY	28480	04271-77213
A11	04271-87213	1	PC BOARD BLANK	28480	04271-87213
A11C1	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C2	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C3	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C4	0160-2199		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A11C5	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C6	0160-2204		CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A11C7	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A11C8	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C9	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C10	0160-2262		CAPACITOR-FXD 18PF +-5% 500VDC CER 0+-30	28480	0160-2262
A11C11	0160-2201	1	CAPACITOR-FXD 51PF +-5% 300VDC MICA	28480	0160-2201
A11C12	0160-2211	1	CAPACITOR-FXD 510PF +-5% 300VDC MICA	28480	0160-2211
A11C13	0160-1944	3	CAPACITOR-FXD MY 4700 PF 5% 50VDC	28480	0160-1944
A11C14	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C15	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A11C16	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A11C17	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C18	0160-2264		CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2264
A11C19	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C20	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C21	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C22	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A11C23	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C24	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A11C25	0160-2264		CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2264

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A26	04271-77232	1	PRNTR SER BCD OUTP DETCTR ASSY(CPT,004)	28480	04271-77232
A26	04271-67232	1	PC BOARD BLANK	28480	04271-67232
A26C1	0160-1271		CAPXD MY 0.01 UF 5% 50VDCM	28480	0160-1271
A26C2	0160-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035B2
A26C3	0180-1735		CAPACITOR-FXD ,22UF+-10% 35VDC TA	56289	150D224X9035B2
A26Q1	1854-0854		TRANSISTOR NPN SI		
A26R1	0683-2715		RESISTOR 270 5% ,25W PC TC=-400/+600	01121	CB2715
A26R2	0681-1035		RESISTOR 10K 5% ,25W PC TC=-400/+700	01121	CB1035
A26R3	0683-2715		RESISTOR 270 5% ,25W PC TC=-400/+600	01121	CB2715
A26R4	0683-1025		RESISTOR 1K 5% ,25W PC TC=-400/+600	01121	CB1025
A26U1	1820-0174		IC INV TTL HEX 1-INP	01295	SN7404N
A26U2	1820-0058		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A26U3	1820-0328		IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
A26U4	1820-0174		IC INV TTL HEX 1-INP	01295	SN7404N
A26U5	1820-0072		IC GATE TTL AND-OR-INV DUAL 2-INP	01295	SN7450N
A26U6	1820-0072		IC GATE TTL AND-OR-INV DUAL 2-INP	01295	SN7450N
A26U7	1820-0068	1	IC GATE TTL NAND TPL 3-INP	01295	SN7410N
A26U8	1820-0058		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A26U9	1820-0058		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A26U10	1820-0058		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A26U11	1820-0058		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A26U12	1820-0058		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A26U13	1820-0058		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A26U14	1820-0072		IC GATE TTL AND-OR-INV DUAL 2-INP	01295	SN7450N
A27- A30			NOT ASSIGNED		
A31	04271-26551	1	PC BOARD BLANK	28480	04271-26551
A31	04271-66551	1	MS-IB CPU ASSY (CPT,101)	28480	04271-66551
A31C1	0180-0228		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A31C2	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
A31C3	0180-0228		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A31C4	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
A31C5	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
A31CR1	1901-0028		DIODE-ZNR 7,5V 5% DO-7 PD=,4W TC=+,05%	28480	1902-0048
A31CR2	1901-0118	1	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0028
			DIODE-ZNR 9,76V 2% DO-7 PD=,4W TC=+,076%	28480	1902-3156
A31J1	0360-1706	1	CABLE TRANSITION 50-TERM INSUL DEPL TYPE	28480	0360-1706
A31L1	9140-0096	1	COIL-MLD 1UH 10% Q=50 ,155OK,375LG=NOM	28480	9140-0096
A31Q1	1854-0039		TRANSISTOR NPN 2N3053 SI TO-39 PD=1W	04713	2N3053
A31R1	0683-1025		RESISTOR 1K 5% ,25W PC TC=-400/+600	01121	CB1025
A31R2	0683-4715		RESISTOR 470 5% ,25W PC TC=-400/+600	01121	CB4715
A31R3	0698-4435	1	RESISTOR 2,49K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-2491-F
A31R4	0683-1045		RESISTOR 100K 5% ,25W PC TC=-400/+600	01121	CB1045
A31R5	0683-1025		RESISTOR 1K 5% ,25W PC TC=-400/+600	01121	CB1025
A31R6	0683-1025		RESISTOR 1K 5% ,25W PC TC=-400/+600	01121	CB1025
A31R7	0683-2425		RESISTOR 2,4K 5% ,25W PC TC=-400/+700	01121	CB2425
A31R8	0683-2425		RESISTOR 2,4K 5% ,25W PC TC=-400/+700	01121	CB2425
A31R9	0683-2425		RESISTOR 2,4K 5% ,25W PC TC=-400/+700	01121	CB2425
A31R10	0683-1025		RESISTOR 1K 5% ,25W PC TC=-400/+600	01121	CB1025
A31R11	0683-1055	1	RESISTOR 1M 5% ,25W PC TC=-400/+600	01121	CB1055
A31R12	0757-0438		RESISTOR 5,11K 1% ,125W F TC=0+-10	24546	C4-1/8-T0-5111-F
A31R13	0683-1815	1	RESISTOR 180 5% ,25W PC TC=-400/+600	01121	CB1815
A31R14	0683-5625		RESISTOR 5,6K 5% ,25W PC TC=-400/+700	01121	CB5625
A31R15	0683-5625		RESISTOR 5,6K 5% ,25W PC TC=-400/+700	01121	CB5625
A31R16	2100-2889	1	RESISTOR-TRMR 5K 10% C SIDE-ADJ 1-TRN	30983	ET50X502
A31U1	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A31U2	1810-1195	11	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A31U3	1820-1195		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A31U4	1820-1195		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A31U5	1820-1195		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A31U6	1820-1195		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A31U7	1820-1208	1	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A31U8	1820-1195		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A31U9	1820-0871	1	IC INV TTL HEX 1-INP	01295	SN7404N
A31U10	1820-1418	1	IC DCDR TTL LS BCD-TO-DEC 8-TO-10-LINE	01295	SN74LS42N

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A31U11	1820-1199		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A31U12	1820-0222	1	IC OP AMP 14-DIP-P	07933	RC4136CB
A31U13	1820-1081	2	IC DRVR TTL BUS DRVR QUAD 1-INP	18324	N8T26B
A31U14	1820-1081		IC DRVR TTL BUS DRVR QUAD 1-INP	18324	N8T26B
A31U15	1820-1691	1	IC MICPROC MOD	28480	1820-1691
A31U16	0427I-85001	1	PROM	28480	04271-85001
A31W1	04271-61603	1	CABLE ASSY CPU	28480	04271-61603
A32	04271-26552	1	PC BOARD BLANK	28480	04271-26552
A32	04271-66552	1	HP-IB CONTROL ASSY (OPT.101)	28480	04271-66552
A32C1	0160-0158	1	CAPACITOR-FXD 5600PF +-10% 200VDC POLYE	28480	0160-0158
A32C2	0160-0155	1	CAPACITOR-FXD 3300PF +-10% 200VDC POLYE	28480	0160-0155
A32R1	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	28480	C4-1/8-TO-5111-F
A32R2	1820-0136	1		28480	1820-0136
A32R3	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A32R4	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A32R5	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A32R6	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A32U1	1820-0261	1	IC MV TTL MONOSTBL	01295	SN74121N
A32U2	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A32U3	1820-1195		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A32U4	1820-1195		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A32U5	1820-1558	2	IC MISC TTL+ QUAD	04713	MC3441P
A32U6	1820-1558		IC MISC TTL+ QUAD	04713	MC3441P
A32U7	1820-1438	2	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257N
A32U8	1820-1438		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257N
A32U9	1820-0021	3	IC BFR TTL NAND QUAD 2-INP	01295	SN7438N
A32U10	1820-0021		IC BFR TTL NAND QUAD 2-INP	01295	SN7438N
A32U11	1820-1195		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A32U12	1820-1195		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A32U13	1820-1199		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A32U14	1820-1199		IC INV TTL LS HEX 1-INP	01295	SN74LS00N
A32U15	1820-0021		IC BFR TTL NAND QUAD 2-INP	01295	SN7438N
A33R3	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A33R4	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A33R5	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A33R6	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A33R7	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A33R8	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A33R9	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A33R10	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A33R11	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A33R12	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A33S1	3101-2061	1	SWITCH-RKR DIP-RKR-ASSY 2-1A NB .05A	28480	3101-2061
A33U1	1820-1199		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A33U2	1820-1199		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A33U3	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A33U4	1820-1199		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A33U5	1820-1199		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A33U6	1820-1238	4	IC MUXR/DATA-SEL TTL LS 4-TO-1-LINE DUAL	01295	SN74LS253N
A33U7	1820-1238		IC MUXR/DATA-SEL TTL LS 4-TO-1-LINE DUAL	01295	SN74LS253N
A33U8	1820-1238		IC MUXR/DATA-SEL TTL LS 4-TO-1-LINE DUAL	01295	SN74LS253N
A33U9	1820-1238		IC MUXR/DATA-SEL TTL LS 4-TO-1-LINE DUAL	01295	SN74LS253N
A33U10	1820-1195		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A34	04271-26554	1	PC BOARD BLANK	28480	04271-26554
A34	04271-66554	1	HP-IB CONNECTOR ASSY(OPT.101)	28480	04271-66554
A34J1	1200-0482	2	SOCKET-IC 16 PIN		
A34J2	1200-0482		SOCKET-IC 16 PIN		
A34J3	1200-0485	1	SKT-IC,14 PIN; PC MTG; RT ANGL CONT	28480	1200-0485
A34J4	1251-3283	1	CONNECTOR 24-PIN F		
A34S1	3101-1973	1	SWITCH-SL 7-1A-NB DIP-SLIDE-ASSY .1A	28480	3101-1973
A35	04271-77238	1	EXTERNAL TRIGGER ASSY (OPT,002,003,004)	28480	0271-77238
A35	04271-87238	1	PC BOARD BLANK	28480	04271-87238

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			CHASSIS MOUNTED PARTS		
C1	0180-1047	2	C:FXD AL ELECT 4.7mF 25VDCW	28480	0180-1047
C2	0180-1047		C:FXD AL ELECT 4.7mF 25VDCW	28480	0180-1047
C3	0180-1048	1	C:FXD AL ELECT 10mF 16VDCW	28480	0180-1048
CR					
CR1	1901-0239	2	DIODE:SI 200V 4.5A)	28480	1901-0239
CR2	1901-0239		DIODE:SI 200V 4.5A	28480	1901-0239
CR3	1901-0496	2	DIODE/RECTIFIER:SILICON 100V 12A	04713	SR2080-2
CR4	1901-0496		DIODE/RECTIFIER:SILICON 100V 12A	04713	SR2080-2
CR5	1884-0005	1	DIODE:THRISTOR(SCR) 50V	04713	MCR 649P-2
F1	2110-0007	1	FUSE:CARTRIDGE 1 AMP 250V SLOW BLOW (FOR 100/120V ONLY)	75915	313001
F2	2110-0202	1	FUSE:0.50A 250' SLOW BLOW (FOR 220/240V ONLY)	75915	313.500S
J1	1250-0252	4	CONNECTOR:BNC UNKNOWN TERMINAL	28480	1250-0252
J2	1250-0252		CONNECTOR:BNC UNKNOWN TERMINAL	28480	1250-0252
J3	1250-0252		CONNECTOR:BNC UNKNOWN TERMINAL	28480	1250-0252
J4	1250-0252		CONNECTOR:BNC UNKNOWN TERMINAL	28480	1250-0252
J5	1510-0038	1	BINDING POST:GROUND TERMINAL	28480	1510-0038
J6	1250-0118	4	CONNECTOR:BNC REMOTE TRIGGER	24931	28JR 128-1
J7	1250-0118		CONNECTOR:BNC EXT INPUT	24931	28JR 128-1
J8	1250-0118		CONNECTOR:BNC MONITOR	24931	28JR 128-1
J9	1250-0118		CONNECTOR:BNC PROBE POWER	24931	28JR 128-1
J10	1251-0143	1	CONNECTOR:14 PIN DC BIAS CONTROL (OPT 001)		
J11	1251-0087	3	CONNECTOR:50 PIN DATA OUTPUT(OPT 003, 004)		
J12	1251-0087		CONNECTOR:50 PIN C/L DATA OUTPUT (OPT 002)		
Q1	1854-0063	2	TSTR:SI NPN (2N3055)	80131	2N3055
Q2	1854-0063		TSTR:SI NPN (2N3055)	80131	2N3055
Q3	1853-0181	1	TSTR:SI PNP		
R1	0687-2221	2	R:FXD COMP 2200 OHM 10% 1/2W	01121	EB 2221
R2	0687-2221		R:FXD COMP 2200 OHM 10% 1/2W	01121	EB 2221
R3	0687-3911	1	R:FXD COMP 390 OHM 10% 1/2W	01121	EB3911
R4	0773-0004	1	R:FXD MET OXIDE 10K OHM 6% 5W		
S1	3101-2216	1	SWITCH:FOR AC LINE		
W1	8120-1378	1	CABLE ASSY:AC POWER CORD	70903	BH-70B1
X	0340-0468	4	INSULATOR:TSTR FOR TO-36 PACKAGE	00000	
X	0370-1007	1	KNOB:POINTER, OLIVE BLK, FOR 0.125"SHAFT	28480	0370-1007
X	1200-0080	4	INSULATOR:TRANSISTOR MTG.	71785	294834
X	1490-0030	1	STAND:TILT	28480	1490-0030
X	5000-0050	2	TRIM:SIDES	28480	5000-0050
X	5040-0346	4	INSULATOR:CONNECTOR	28480	5040-0346
X	5060-0730	2	FRAME ASSY:3 X 16	28480	5060-0730
X	5060-0767	6	FOOT ASSY:FM	28480	5060-0767
X	0960-0443	1	POWER MODULE	28480	5060-0767
X	8710-0740	1	SCREW DRIVER	460	0960-0443
X					
X	03480-04107	2	COVER:SIDE B	28480	03480-04107
X	04271-00101	1	DECK-R	28480	04271-00101
X	04271-00201	1	PANEL:FRONT HP(EXPORT ONLY)	28480	04271-00201
X	04271-00202	1	PANEL:FRONT YHP (DOMESTIC ONLY)	28480	04271-00202
X	04271-00203	1	SUB-PANEL	28480	04271-00203
X	04271-00204	1	FRAME:WINDOW	28480	04271-00204
X	04271-00210	1	PANEL:REAR	28480	04271-00210
X	04271-00632	1	PLATE		
X	04271-10027	1	COVER:TOP	28480	04271-10027
X	04271-10028	1	COVER:BOTTOM	28480	04271-10028
X	04271-10030	2	PLATE		
X	04271-10031	1	DECK-F	28480	04271-10030
X	04271-01206	1	BRACKET:F1	28480	04271-10031
X	04271-01202	1	BRACKET:F2	28480	04271-01206
X	04271-10035	1	BRACKET:F3	28480	04271-01202
Y	04271-01204	1	BRACKET:F4	28480	04271-10035
Y	04271-01205	1	BRACKET:F6	28480	04271-01204
Y	04271-10042	1	BRACKET:R1	28480	04271-01205
Y	04271-10043	1	BRACKET:R2	28480	04271-10042
Y	04271-10044	1	PLATE	28480	04271-10043
Y	04271-10046	5	SHIELD	28480	04271-10044
Y	04271-10047	3	SHIELD	28480	04271-10046
Y	04271-10048	1	SHIELD	28480	04271-10047
Y	04271-10049	1	SHIELD	28480	04271-10048
Y	04271-01201	1	HEAT SINK	28480	04271-10049

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
Y	04271-30023	1	BUSH	28480	04271-30023
Y	04271-50024	4	INSULATOR:BNC	28480	04271-50024
Y	9320-2407		ENVELOPE WARNING 115V ONLY		
Y	9320-0710		ENVELOPE WARNING 100V ONLY		
Y	1205-0013	1	HEAT SINK		
Y	04271-50025	4	INSULATOR:BNC	28480	04271-50025
Y	04271-50028	1	OPT FILTER:BRN	28480	04271-50028
Y				28480	16030A
	04271-72021	1	CABLE ASSY HCUR TERMINAL TO A9 BD		
	04271-72022	3	CABLE ASSY LCUR TERMINAL TO A12 BD		
	04271-72022		CABLE ASSY LPOT TERMINAL TO A11 BD		
	04271-72022		CABLE ASSY HPOT TERMINAL TO A10 BD		
	04271-77224	1	CONNECTION BOARD ASSY ONLY FOR OPT 003, 004		
	04271-77225	1	CONNECTION BOARD ASSY ONLY FOR OPT 002		
	04271-66560	1	CONNECTION BOARD ASSY ONLY FOR OPT 001		

c. A description of the part,

d. A typical manufacturer of the part in a five-digit code,

e. The manufacturer's number for the part.

The total quantity for each part is given only once - at the first appearance of the part number in the list.

6-7. ORDERING INFORMATION.

6-8. To order a part listed in the replaceable parts table, give the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-9. To order a part that is not listed in the replaceable parts table, state the full instrument model and serial number, the description and function of the part, and the number of parts required. Address your order to the nearest Hewlett-Packard office.

6-10. SPARE PARTS KIT.

6-11. Stocking spare parts for an instrument is often done to insure quick return to service after a malfunction occurs. Hewlett-Packard has a Spare Parts Kit available for this purpose. The kit consists of selected replaceable assemblies and components for this instrument. The contents of the kit and the Recommended Spares List are based on failure reports and repair data, and parts support for one year. A complimentary Recommended Spares List for this instrument may be obtained on request and the Spare Parts Kit may be ordered through your nearest Hewlett-Packard office.

6-12. DIRECT MAIL ORDER SYSTEM.

6-13. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are:

a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP Office when the orders require billing and invoicing).

c. Prepaid transportation (there is a small handling charge for each order).

d. No invoices - to provide these advantages, a check or money order must accompany each order.

6-14. Mail order forms and specific ordering information is available through your local HP Office. Addresses and phone numbers are located at the back of this manual.

Table 6-2. Manufacturers Code List.

MFR NO.	MANUFACTURER NAME	ADDRESS		ZIP CODE
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS	TX	75222
01928	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	08876
03888	KDI PYROFILM CORP	WHIPPANY	NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85062
06665	PRECISION MONOLITHICS INC	SANTA CLARA	CA	95050
07933	RAYTHEON CO SEMICONDUCTOR DIV HQ	MOUNTAIN VIEW	CA	94040
18324	SIGNETICS CORP	SUNNYVALE	CA	94086
18736	VOLTRONICS CORP	HANOVER	NJ	07936
19701	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	75067
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
30983	MEPCO/ELECTRA CORP	SAN DIEGO	CA	92121
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE	CA	92507
52763	STETTNER-TRUSH INC	CAZENOVIA	NY	13035
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
72136	ELECTRO MOTIVE CORP SUB IEC	WILLIMANTIC	CT	06226
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON	CA	92634
84411	TRW CAPACITOR DIV	OGALLALA	NE	69153

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A11C26	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A11C27	0160-2203		CAPACITOR-FXD 91PF +-5% 300VDC MICA 0+70	28480	0160-2203
A11C28	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A11C29	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A11C30	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A11C31	0121-0105		CAPACITOR-V TRMR-CER 9-35PF 200V PC-MTG	52763	30-328 9/35PF N+50
A11C32	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C33	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C34	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C35	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C36	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C37	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C38	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C39	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C40	0180-0197	4	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A11C41	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A11C42	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C43	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C44	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C45	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C46	0180-0228	4	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A11C47	0180-0228		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A11C48	0180-0228		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A11C49	0180-0228		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A11C50	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A11C51	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A11CR1	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11CR2	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11CR3	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A11CR4	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A11CR5	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11CR6	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11CR7	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11CR8	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11CR9	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11CR10	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11CR11	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11CR12	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=+.005%	28480	1902-0041
A11CR13	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11CR14	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A11J1	1250-0257		CONNECTOR-RF BNC M PC 50-OHM	28480	1250-0257
A11K1	0490-0218	3	RELAY-REED SPST 12VDC	28480	0490-0218
A11K2	0490-0218		RELAY-REED SPST 12VDC	28480	0490-0218
A11K3	0490-0218		RELAY-REED SPST 12VDC	28480	0490-0218
A11L1	9140-0137		COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A11L2	9140-0137		COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A11L3	9140-0137		COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A11L4	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-NOM	28480	9140-0129
A11L5	9140-0137		COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A11L6	9140-0137		COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A11L7	9140-0137		COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A11Q1	1853-0036	2	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A11Q2	1853-0036		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A11Q3	1854-0053		TRANSISTOR NPN SI		
A11Q4	1854-0053		TRANSISTOR NPN SI		
A11Q5	1854-0053		TRANSISTOR NPN SI		
A11Q6	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A11Q7	1854-0053		TRANSISTOR NPN SI		
A11Q8	1854-0053		TRANSISTOR NPN SI		
A11Q9	1854-0053		TRANSISTOR NPN SI		
A11Q10	1854-0053		TRANSISTOR NPN SI		
A11J11	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	[illegible]	1853-0020
A11Q12	1854-0053		TRANSISTOR NPN SI		
A11Q13	1854-0053		TRANSISTOR NPN SI		
A11Q14	1854-0053		TRANSISTOR NPN SI		
A11Q15	1853-0041		TRANSISTOR NPN SI		
A11Q16	1854-0053		TRANSISTOR NPN SI		
A11Q17	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A11Q18	1854-0053		TRANSISTOR NPN SI		
A11Q19	1854-0041		TRANSISTOR NPN SI		
A11Q20	1854-0053		TRANSISTOR NPN SI		
A11R1	0698-3150		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A11R2	0683-3315	4	RESISTOR 330 5% .25W FC TC=-400/+800	01121	CB3315
A11R3	0683-3315		RESISTOR 330 5% .25W FC TC=-400/+800	01121	CB3315
A11R4	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A11R5	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325

Table 6-3. Replaceable Parts.

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	04271-26501	1	PC BOARD BLANK	28480	04271-26501
A1	04271-66521	1	MOTHER BOARD ASSY	28480	04271-66521
A1CR1	1910-0031	1	DIODE-GE 30V 80MA 8NS DO-7	28480	1910-0031
A1R1	0683-1025	1	RESISTOR 1K 5% .25W FC TC=+400/+800	01121	CB1025
A1R3	0683-3915	21	RESISTOR 390 5% .25W FC TC=+400/+800	01121	CB3915
A1R4	0683-1025		RESISTOR 1K 5% .25W FC TC=+400/+800	01121	CB1025
A1R5	0683-3915		RESISTOR 390 5% .25W FC TC=+400/+800	01121	CB3915
A1XP1L	[illegible]	1	CONNECTOR - PC	28480	[illegible]
A1XP2L	[illegible]		CONNECTOR - PC	28480	[illegible]
A1XP3L	[illegible]		CONNECTOR - PC	28480	[illegible]
A1XP4	04271-20031	2	CONNECTOR-PC	28480	04271-20031
A1XA1M	1251-1886	22	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA1L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA2L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA3L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA3M	[illegible]		CONNECTOR-PC EDGE [illegible]	[illegible]	[illegible]
A1XA4L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA5	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA6L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA7L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA7M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA8L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA9L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA9M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA10L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA10M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA11L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA11M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA12L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA12M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA13L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA13M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA14L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA14M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA15L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA15M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA16L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA16M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA17L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA17M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA18L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA18M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA19L	1251-1886	1	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA19M	[illegible]		CONNECTOR-PC EDGE [illegible]	[illegible]	[illegible]
A1XA20L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA20M	[illegible]		CONNECTOR-PC EDGE [illegible]	[illegible]	[illegible]
A1XA21L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA21M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA22L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA22M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA23L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA23M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA24L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA24M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA25L	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA25M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A1XA26	1251-0737	1	CONNECTOR-PC EDGE 25-CONT/ROW 2-ROWS	28480	1251-0737
A1XA27	04271-30031		CONNECTOR-PC	28480	04271-30031
A1XA28	1251-0478	1	CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0478
A1XA31M	1251-1886		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1886
A2	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]		[illegible]	[illegible]	[illegible]
A2A1	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
A2A1A1	[illegible]	1	[illegible]		
A2A1A2 A2A1A3	[illegible]		[illegible]		
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
A2A1	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
	[illegible]	1	[illegible]	[illegible]	[illegible]
A3	04271-26505	1	PC BOARD BLANK	28480	04271-26505
A3	04271-66505	1	DC POWER SUPPLY ASSY	28480	04271-66505
A3C1	0180-1055	1	C:FXD AL ELECT 100 UF 100VDC+	28480	0180-1055
A3C2	0180-1056	1	C:FXD AL ELECT 47 UF 100VDC+	28480	0180-1056
A3C3	0180-0947	2	C:FXD AL ELECT 220 UF 10VDC+	28480	0180-0947
A3C4	0180-0947		C:FXD AL ELECT 220 UF 10VDC+	28480	0180-0947
A3C5	0180-0958	1	C:FXD AL ELECT 470 UF 6.3VDC+	28480	0180-0958

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A11R6	0683-5105		RESISTOR 51 5% .25W FC TC=+400/+500	01121	CB5105
A11R7	0683-2725		RESISTOR 2.7K 5% .25W FC TC=+400/+700	01121	CB2725
A11R8	0683-1015		RESISTOR 100 5% .25W FC TC=+400/+500	01121	CB1015
A11R9	0683-5105		RESISTOR 51 5% .25W FC TC=+400/+500	01121	CB5105
A11R10	0683-2205		RESISTOR 22 5% .25W FC TC=+400/+500	01121	CB2205
A11R11	0683-2425		RESISTOR 2.4K 5% .25W FC TC=+400/+700	01121	CB2425
A11R12	0683-1015		RESISTOR 100 5% .25W FC TC=+400/+500	01121	CB1015
A11R13	0683-1015		RESISTOR 100 5% .25W FC TC=+400/+500	01121	CB1015
A11R14	0683-0515		RESISTOR 5.1 5% .25W FC TC=+400/+500	01121	CB5105
A11R15	0683-0515		RESISTOR 5.1 5% .25W FC TC=+400/+500	01121	CB5105
A11R16	0683-1015		RESISTOR 100 5% .25W FC TC=+400/+500	01121	CB1015
A11R17	0683-2205		RESISTOR 22 5% .25W FC TC=+400/+500	01121	CB2205
A11R18	0757-0402		RESISTOR 10K 1% .125W F TC=0++100	24546	C4-1/8-T0-1002-F
A11R19	0757-0279	1	RESISTOR 3.16K 1% .125W F TC=0++100	24546	C4-1/8-T0-3161-F
A11R20	0698-3446	1	RESISTOR 316 1% .125W F TC=0++100	24546	C4-1/8-T0-316R-F
A11R21	0757-0180	1	RESISTOR 31.6 1% .125W F TC=0++100	28480	0757-0180
A11R22	0698-0084		RESISTOR 2.15K 1% .125W F TC=0++100	24546	C4-1/8-T0-2151-F
A11R23	0757-0397		RESISTOR 68.1 1% .125W F TC=0++100	24546	C4-1/8-T0-68R1-F
A11R24	0757-0442		RESISTOR 10K 1% .125W F TC=0++100	24546	C4-1/8-T0-1002-F
A11R25	0683-3305	2	RESISTOR 33 5% .25W FC TC=+400/+500	01121	CB3305
A11R26	0683-3325		RESISTOR 3.3K 5% .25W FC TC=+400/+700	01121	CB3325
A11R27	0683-3305		RESISTOR 33 5% .25W FC TC=+400/+500	01121	CB3305
A11R28	0698-0084		RESISTOR 2.15K 1% .125W F TC=0++100	24546	C4-1/8-T0-2151-F
A11R29	0757-0401		RESISTOR 100 1% .125W F TC=0++100	24546	C4-1/8-T0-101-F
A11R30	0683-3925		RESISTOR 3.9K 5% .25W FC TC=+400/+700	01121	CB3925
A11R31	0683-2025		RESISTOR 2K 5% .25W FC TC=+400/+700	01121	CB2025
A11R32	0698-0084		RESISTOR 2.15K 1% .125W F TC=0++100	24546	C4-1/8-T0-2151-F
A11R33	0698-3441	2	RESISTOR 215 1% .125W F TC=0++100	24546	C4-1/8-T0-215R-F
A11R34	0683-3925		RESISTOR 3.9K 5% .25W FC TC=+400/+700	01121	CB3925
A11R35	0683-1525		RESISTOR 1.5K 5% .25W FC TC=+400/+700	01121	CB1525
A11R36	0683-1015		RESISTOR 100 5% .25W FC TC=+400/+500	01121	CB1015
A11R37	0683-4725		RESISTOR 4.7K 5% .25W FC TC=+400/+700	01121	CB4725
A11R38	0683-2425		RESISTOR 2.4K 5% .25W FC TC=+400/+700	01121	CB2425
A11R39	0757-0438		RESISTOR 5.11K 1% .125W F TC=0++100	24546	C4-1/8-T0-5111-F
A11R40	0757-0280		RESISTOR 1K 1% .125W F TC=0++100	24546	C4-1/8-T0-1001-F
A11R41	0757-0438		RESISTOR 5.11K 1% .125W F TC=0++100	24546	C4-1/8-T0-5111-F
A11R42	0683-1525		RESISTOR 1.5K 5% .25W FC TC=+400/+700	01121	CB1525
A11R43	0683-2235		RESISTOR 22K 5% .25W FC TC=+400/+800	01121	CB2235
A11R44	0683-2235		RESISTOR 22K 5% .25W FC TC=+400/+800	01121	CB2235
A11R45	0683-2235		RESISTOR 22K 5% .25W FC TC=+400/+800	01121	CB2235
A11R46	0683-3335		RESISTOR 33K 5% .25W FC TC=+400/+800	01121	CB3335
A11R47	0683-1005		RESISTOR 10 5% .25W FC TC=+400/+500	01121	CB1005
A11R48	0683-9135	1	RESISTOR 91K 5% .25W FC TC=+400/+800	01121	CB9135
A11R49	0683-3335		RESISTOR 33K 5% .25W FC TC=+400/+800	01121	CB3335
A11R50	0698-3456	1	RESISTOR 215K 1% .125W F TC=0++100	24546	C4-1/8-T0-2153-F
A11R51	0757-0442		RESISTOR 10K 1% .125W F TC=0++100	24546	C4-1/8-T0-1002-F
A11R52	0683-5125		RESISTOR 5.1K 5% .25W FC TC=+400/+700	01121	CB5125
A11R53	0683-3935		RESISTOR 39K 5% .25W FC TC=+400/+800	01121	CB3935
A11R54	0683-1035		RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
A11R55	0683-1035		RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
A11R58	0683-5125		RESISTOR 5.1K 5% .25W FC TC=+400/+700	01121	CB5125
A11T1	9100-0823		TRANSFORMER(TOK:13381) 11111	28480	9100-0823
A11T2	9100-0823		TRANSFORMER(TOK:13381) 11111	28480	9100-0823
A12	04271-77214	1	A/D & OFFSET CIRCUIT ASSY	28480	04271-77214
A12	04271-87214	1	PC BOARD BLANK	28480	04271-87214
A12C1	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A12C2	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A12C3	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A12C4	0121-0038	3	CAPACITOR-V TRMR-CER 5.5-18PF 350V	52763	304328 5.5/18PF APC
A12C5	0160-2259	1	CAPACITOR-FXD 12PF +-5% 500VDC CER 0++30	28480	0160-2259
A12C6	0160-1271	6	CAPACITOR-FXD MY 0.01 UF 5% 50VDC M	28480	0160-1271
A12C7	0140-0210	1	CAPACITOR-FXD 270PF +-5% 300VDC MICA	72136	DM19F271J0300WV1CR
A12C8	[illegible]		CAPACITOR-V TRMR-CER [illegible]	52763	304324 [illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3C6	0180-0124	1	CAPACITOR-FXD 220PF +-5% 300VDC MICA	28480	0180-0124
A3C7	0180-0291	15	CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A3C8	0180-0291		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A3C9	0180-0127	39	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0180-0127
A3C10	0180-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER		
A3C11	0180-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER		
A3CR1	1901-0028	8	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A3CR2	1901-0028		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A3CR3	1901-0028		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A3CR4	1901-0028		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A3CR5	1902-0555	8	DIODE-ZNR 20V 5% DO-15 PD=1W TC=+.073%	28480	1902-0555
A3CR6	1902-0555		DIODE-ZNR 20V 5% DO-15 PD=1W TC=+.073%	28480	1902-0555
A3CR7	1902-3182	1	DIODE-ZNR 12.1V 5% DO-7 PD=.4W TC=+.064%	28480	1902-3182
A3CR8	1902-0777	2	DIODE-ZNR 6.2V 5% DO-7 PD=.4W	04713	1N829
A3CR9	1902-3185	1	DIODE-ZNR 23.7V 5% DO-7 PD=.4W TC=+.076%	28480	1902-3185
A3CR10	1902-0049	8	DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	28480	1902-0049
A3U1	1820-0803	7	IC DTL OP AMP TO-99	01295	SN72741
A3U2	1820-0803		IC DTL OP AMP TO-99	01295	SN72741
A3Q1	1854-0039	6	TRANSISTOR NPN 2N3053 SI TO-39 PD=1W	04713	2N3053
A3Q2	1854-0853	(+)	TRANSISTOR NPN SI		
A3Q3	1854-0039		TRANSISTOR NPN 2N3053 SI TO-39 PD=1W	04713	2N3053
A3Q4	1854-0853		TRANSISTOR NPN SI		
A3Q5	1853-0020	49	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A3Q6	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A3Q7	1853-0012	7	TRANSISTOR PNP 2N2904A SI TO-39 PD=600MW	01295	2N2904A
A3Q8	1854-0071		TRANSISTOR NPN SI		
A3Q9	1853-0012		TRANSISTOR PNP 2N2904A SI TO-39 PD=600MW	01295	2N2904A
A3Q10	1854-0853		TRANSISTOR NPN SI		
A3Q11	1854-0853		TRANSISTOR NPN SI		
A3R1	0683-1215	3	RESISTOR 120 5% .25W FC TC=+400/+800	01121	CB1215
A3R2	0683-1215		RESISTOR 120 5% .25W FC TC=+400/+800	01121	CB1215
A3R3	0686-5125	2	RESISTOR 5.1K 5% .5W CC TC=0+647	01121	EB5125
A3R4	0761-0015	2	RESISTOR 1.5K 1% 1W MO TC=0+200	28480	0761-0015
A3R5	0761-0015		RESISTOR 1.5K 1% 1W MO TC=0+200	28480	0761-0015
A3R6	0812-0072	2	RESISTOR 23 5% 3W PW TC=0+-90	28480	0812-0072
A3R7	0683-5125	10	RESISTOR 5.1K 5% .25W FC TC=+400/+700	01121	CB5125
A3R8	0683-1035	18	RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
A3R9	0683-1035		RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
A3R10	0698-8471	1	RESISTOR 7.15K 1% .125W F TC=0+-100	28480	CA=1/8=TO=7151=F
A3R11	0757-0438	10	RESISTOR 5.11K 1% .125W F TC=0+-100	28480	CA=1/8=TO=5111=F
A3R12	0757-0419	2	RESISTOR 681 1% .125W F TC=0+-100	28480	CA=1/8=TO=6810=F
A3R13	0757-0280	6	RESISTOR 1K 1% .125W F TC=0+-100	28480	CA=1/8=TO=1001=F
A3R14	2100-1232	1	RESISTOR, VAR CERMET 1K 10% LIN 1/2W	28480	2100-1232
A3R15	0698-3515	2	RESISTOR 5.9K 1% .125W F TC=0+-100	28480	CA=1/8=TO=5901=F
A3R16	0812-0072		RESISTOR 23 5% 3W PW TC=0+-90	28480	0812-0072
A3R17	0683-5125		RESISTOR 5.1K 5% .25W FC TC=+400/+700	01121	CB5125
A3R18	0698-2188	2	RESISTOR MET FLM 7K OHM 0.25% 1/8W	28480	0698-2188
A3R19	0698-2188		RESISTOR MET FLM 7K OHM 0.25% 1/8W	28480	0698-2188
A3R20	0683-3925	2	RESISTOR 3.9K 5% .25W FC TC=+400/+700	01121	CB3925
A3R21	0683-1025		RESISTOR 1K 5% .25W FC TC=+400/+700	01121	CB1025
A3R22	0683-1025	3	RESISTOR 1K 5% .25W FC TC=+400/+700	01121	CB1025
A3R23	0683-1845	1	RESISTOR 180K 5% .25W FC TC=+400/+700	01121	CB1845
A3R24	0683-3925		RESISTOR 3.9K 5% .25W FC TC=+400/+700	01121	CB3925
A3R25	0683-7525	2	RESISTOR 7.5K 5% .25W FC TC=+400/+700	01121	CB7525
A3R26	0760-0024	1	RESISTOR 100 5% 1W MO TC=0+-200	28480	0760-0024
A3R27	0757-0439	1	RESISTOR 6.81K 1% .125W F TC=0+-100	28480	CA=1/8=TO=6811=F
A3R28	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	28480	CA=1/8=TO=5111=F
A3R29	0683-5125		RESISTOR 5.1K 5% .25W FC TC=+400/+700	01121	CB5125
A3R30	0811-2816	2	RESISTOR .12 3% 3W PW TC=0+-90	28480	0811-2816
A3R31	0811-2816		RESISTOR .12 3% 3W PW TC=0+-90	28480	0811-2816
A3R32	0757-0198	1	RESISTOR 100 1% .5W F TC=0+-100	28480	0757-0198
A3R33	0683-1025		RESISTOR 1K 5% .25W FC TC=+400/+700	01121	CB1025
A3R34	0683-5125		RESISTOR 5.1K 5% .25W FC TC=+400/+700	01121	CB5125
A3R35	0683-5125		RESISTOR 5.1K 5% .25W FC TC=+400/+700	01121	CB5125
A3R36	0683-1035		RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
A3R37	0683-2025	4	RESISTOR 2K 5% .25W FC TC=+400/+700	01121	CB2025
A3R38	0683-1025		RESISTOR 1K 5% .25W FC TC=+400/+700	01121	CB1025
A3R39	0683-4315	1	RESISTOR 430 5% .25W FC TC=+400/+600	01121	CB4315
	1205-0033	1	HEAT SINK TO-5/TO-39=PKG	28480	1205-0033
A4	04271-77206	1	OSCILLATOR ASSY	28480	04271-77206
A4	04271-87206	1	PC BOARD BLANK	28480	04271-87206
A4C1	0180-0121	88	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0180-0121
A4C2	0160-2210	1	CAPACITOR-FXD 470PF +-5% 300VDC MICA	28480	0160-2210
A4C3	0160-2307	3	CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A4C4	0160-2204	3	CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A4C5*	0180-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0180-0121

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A12C18	0160-0939		CAPACITOR-FXD 430PF +-5% 300VDC MICA	28480	0160-0939
A12C19	0160-0939		CAPACITOR-FXD 430PF +-5% 300VDC MICA	28480	0160-0939
A12C20	0160-2263		CAPACITOR-FXD 18PF +-5% 500VDC CER 0+-30	28480	0160-2263
A12C21	0160-2307		CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A12C22	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C23	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C24	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A12C25	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A12C26	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C27	0160-2308	2	CAPACITOR-FXD 36PF +-5% 300VDC MICA	28480	0160-2308
A12C28*	[illegible]		CAPACITOR-FXD [illegible] +-.25PF 500VDC CER	28480	[illegible]
A12C29	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C30	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C31	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C32	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C33	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C34	0160-2308		CAPACITOR-FXD 36PF +-5% 300VDC MICA	28480	0160-2308
A12C35	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A12C36	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A12CR1	1902-3082	1	DIODE-ZNR 6.04V 5% DO-7 PD=.4W TC=-.023%	28480	1902-3082
A12CR2	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A12CR3	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A12CR4	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A12CR5	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A12CR6	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A12CR7	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A12CR8	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A12CR9	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A12CR10	0122-0105	2	CAPACITOR, VOLTAGE REGULATOR	28480	0122-0105
A12CR11	0122-0106	1		28480	0122-0106
A12CR12	0122-0105		CAPACITOR, VOLTAGE REGULATOR	28480	0122-0105
A12CR13	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR14	5080-3039			28480	5080-3039
A12CR15	5080-3039			28480	5080-3039
A12J1	1250-0257		CONNECTOR-RF SMB - PC 50-OHM	28480	1250-0257
A12K1	0490-0234		RELAY, REED	28480	0490-0234
A12K2	0490-0234		RELAY, REED	28480	0490-0234
A12K3	0490-0234		RELAY, REED	28480	0490-0234
A12K4	0490-0234		RELAY, REED	28480	0490-0234
A12L1	9100-1049	1	COIL-MLD 820UH 5% Q=60 .190DX.44LG-NOM	28480	9100-1049
A12L2	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-NOM	28480	9140-0129
A12L3	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-NOM	28480	9140-0129
A12L4	9140-0114	1	COIL-MLD 10UH 10% Q=55 .159DX.375LG-NOM	28480	9140-0114
A12L5	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-NOM	28480	9140-0129
A12Q1	[illegible]		TRANSISTOR NPN SI		
A12Q2	[illegible]		TRANSISTOR NPN SI		
A12Q3	[illegible]		TRANSISTOR NPN SI		
A12Q4	[illegible]		TRANSISTOR NPN SI		
A12Q5	[illegible]		TRANSISTOR NPN SI		
A12Q6	[illegible]		TRANSISTOR NPN SI		
A12Q7	[illegible]		TRANSISTOR NPN SI		
A12Q8	[illegible]		TRANSISTOR NPN SI		
A12Q9	[illegible]		TRANSISTOR NPN SI		
A12Q10	[illegible]		TRANSISTOR NPN SI		
A12Q11	[illegible]		TRANSISTOR NPN SI		
A12Q12	[illegible]		TRANSISTOR NPN SI		
A12Q13	[illegible]		TRANSISTOR NPN SI		
A12R1	0698-3155		RESISTOR 8.06K 1% .125W F TC=0+-100	24546	C4-1/8-TO-8061-F
A12R2	0683-2425		RESISTOR 2.4K 5% .25W FC TC=+400/+700	01121	CB2425
A12R3	0683-1025		RESISTOR 1K 5% .25W FC TC=+400/+800	01121	CB1025
A12R4	0683-3005	3	RESISTOR 30 5% .25W FC TC=+400/+500	01121	CB3005
A12R5	0683-5105		RESISTOR 51 5% .25W FC TC=+400/+500	01121	CB5105
A12R6	0683-4725		RESISTOR 4.7K 5% .25W FC TC=+400/+700	01121	CB4725
A12R7	0698-4425	3	RESISTOR 1.5MK 1% .125W F TC=0+-100	24546	C4-1/8-TO-1501-F
A12R8	2100-2578	3	RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	30983	ET50X501
A12R9	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A12R10	0698-3540	2	RESISTOR 15.4K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1542-F
A12R11	0698-2192		RESISTOR MET FLM 91.17 OHM 0.1% 1/8W	28480	0698-2192
A12R12	2100-3356		RESISTOR-TRMR 50K 10% C SIDE-ADJ 1-TRN	28480	2100-3356
A12R13*	0757-0444	1	RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1212-F
A12R14	0698-2193	1	RESISTOR MET FLM 10.5 OHM 0.25% 1W	28480	0698-2193
A12R15*	0698-3440	1	RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-TO-196R-F
A12R16	2100-2520		RESISTOR-TRMR 50 20% C SIDE-ADJ 1-TRN	30983	ET50X500
A12R17	0698-3433	1	RESISTOR 28.7 1% .125W F TC=0+-100	03888	PME55-1/8-TO-28R7-F
A12R18	2100-1238		RESISTOR, VAR CERMET 10K 10% LIN 1/2W	28480	2100-1238
A12R19*	0698-3152	1	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3481-F
A12R20	0698-2191	1	RESISTOR MET FLM 10795 OHM 0.1% 1/8W	28480	0698-2191

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4C6	0180-0181		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0180-0181
A4C7	0180-0181		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0180-0181
A4C8	0180-0181		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0180-0181
A4C9	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A4C10	0180-0374	6	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A4C11	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A4C12	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A4CR1	1902-0048	1	DIODE-ZNR 6.81V 5% DO-7 PD=.4W TC=+.043%	28480	1902-0048
A4CR2	1902-3189	6	DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	28480	1902-3189
A4CR3	1910-0077	41	DIODE-GE 20V 60MA 10% DO-7	28480	1910-0077
A4CR4	1910-0077		DIODE-GE 20V 60MA 10% DO-7	28480	1910-0077
A4L1	9100-0828	1	COIL/CHOKE 100 UH 10%	28480	9100-0828
A4L2	9140-0210	6	COIL-MLD 100UH 5% Q=50 .188DX.378LG-NOM	28480	9140-0210
A4L3	9140-0210		COIL-MLD 100UH 5% Q=50 .188DX.378LG-NOM	28480	9140-0210
A4Q1	1855-0081	3	TRANSISTOR J-FET N-CHAN D-MODE BI	01295	2N5248
A4Q2	1893-0020		TRANSISTOR PNP BI PD=300MW FT=150MHZ	28480	1893-0020
A4Q3	1854-0064		TRANSISTOR NPN BI		
A4Q4	1854-0064		TRANSISTOR NPN BI		
A4Q5	1893-0020		TRANSISTOR PNP BI PD=300MW FT=150MHZ	28480	1893-0020
A4Q6	1893-0020		TRANSISTOR PNP BI PD=300MW FT=150MHZ	28480	1893-0020
A4Q7	1854-0064		TRANSISTOR NPN BI		
A4Q8	1854-0064		TRANSISTOR NPN BI		
A4Q9	1854-0064		TRANSISTOR NPN BI		
A4Q10	1893-0020		TRANSISTOR PNP BI PD=300MW FT=150MHZ	28480	1893-0020
A4R1	0683-4F35	1	RESISTOR 68K 5% .25W FC TC=+400/+800	01121	CB6835
A4R2	0683-2715	16	RESISTOR 270 5% .25W FC TC=+400/+800	01121	CB2715
A4R3	0683-1835	2	RESISTOR 18K 5% .25W FC TC=+400/+800	01121	CB1835
A4R4	0683-3915		RESISTOR 390 5% .25W FC TC=+400/+800	01121	CB3915
A4R5	0683-3025		RESISTOR 3K 5% .25W FC TC=+400/+700	01121	CB3025
A4R6	0683-7925		RESISTOR 7.5K 5% .25W FC TC=+400/+700	01121	CB7925
A4R7	0757-0440	1	RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A4R8	0698-3155	7	RESISTOR 4.86K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4861-F
A4R9	2100-1760	1	RESISTOR-TRMR 5K 5% 1W SIDE-ADJ 1-TRN	28480	2100-1760
A4R10	0683-1035		RESISTOR 10K 5% .25W FC TC=+400/+700	01121	CB1035
A4R11	0683-1015	27	RESISTOR 100 5% .25W FC TC=+400/+800	01121	CB1015
A4R12	0698-0084	12	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A4R13*	0698-4386	1	RESISTOR 59 1% .125W F TC=0+-100	24546	C4-1/8-T0-59R0-F
A4R14	0757-0800	1	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A4R15	0683-4725	7	RESISTOR 4.7K 5% .25W FC TC=+400/+700	01121	CB4725
A4R16	0683-8225	8	RESISTOR 8.2K 5% .25W FC TC=+400/+700	01121	CB8225
A4R17	0683-3335	8	RESISTOR 33K 5% .25W FC TC=+400/+800	01121	CB3335
A4R18	0683-3335		RESISTOR 33K 5% .25W FC TC=+400/+800	01121	CB3335
A4R19	0683-3335		RESISTOR 33K 5% .25W FC TC=+400/+800	01121	CB3335
A4R20	0683-3335		RESISTOR 33K 5% .25W FC TC=+400/+800	01121	CB3335
A4R21	0683-1235	7	RESISTOR 12K 5% .25W FC TC=+400/+800	01121	CB1235
A4T1	9100-0820	1	TRANSFORMER-PULSE	28480	9100-0820
A4Y1	0410-0133	1	CRYSTAL-QUARTZ 999,950 KHZ +-50 HZ: TC	28480	0410-0133
	1200-0199	1	SOCKET-XTAL 2-CONT HC-6/U DIP-SLDR	28480	1200-0199
A5	08271-77207	1	REFERENCE PHASE GENERATOR ASSY	28480	08271-77207
A5	08271-87207	1	PC BOARD ASSY	28480	08271-87207
A5C1	0180-0197	1	CAPACITOR-FXD 180PF +-5% 300VDC MICA	72136	DM15F181J0300WV1CR
A5C2	0121-0105	6	CAPACITOR-V TRMR-CER 9-35PF 200V PC-MTG	52763	304SBS 9/35PF W550
A5C3	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A5C4	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A5C5	0180-0181		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0180-0181
A5C7	0180-0181		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0180-0181
A5C9	0180-0197		CAPACITOR-FXD 180PF +-5% 300VDC MICA	72136	DM15F181J0300WV1CR
A5C10	0121-0105		CAPACITOR-V TRMR-CER 9-35PF 200V PC-MTG	52763	304SBS 9/35PF W550
A5C11	0140-0199	2	CAPACITOR-FXD 240PF +-5% 300VDC MICA	72136	DM15F241J0300WV1CR
A5C12	0160-2253	1	CAPACITOR-FXD 6.8PF +-.25PF 500VDC CER	28480	0160-2253
A5C13	0160-2246	5	CAPACITOR-FXD 3.6PF +-.25PF 500VDC CER	28480	0160-2246
A5C14	0180-0181		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0180-0181
A5C15	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A5C16	0180-0181		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0180-0181
A5C17	01[illegible]	3	CAPACITOR-V TRMR-PSTN .8-8.5PF		
A5C18	0160-2246		CAPACITOR-FXD 3.6PF +-.25PF 500VDC CER	28480	0160-2246
A5C19	0180-0181		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0180-0181
A5C20	0180-0181		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0180-0181
A5C21	0180-0181		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0180-0181
A5C22	0160-2246	1	CAPACITOR-FXD 3.6PF +-.25PF 500VDC CER	28480	0160-2246

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A12R21	2100-2520		RESISTOR-TRMR 50 20% C SIDE-ADJ 1-TRN	30983	ET50X500
A12R22*	0698-3439	1	RESISTOR 178 1% .125W F TC=0+-100	24546	C4-1/8-T0-178R-F
A12R23	0698-2190	1	R:FXD MET FLM 9.6K OHM 0.1% 1/8W	28480	0698-2190
A12R24	0683-3025		RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A12R25	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A12R26	0683-6335	2	RESISTOR 63K 5% .25W FC TC=-400/+800	01121	CB6335
A12R27	0683-6335		RESISTOR 63K 5% .25W FC TC=-400/+800	01121	CB6335
A12R28	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A12R29	0683-2035	28	RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A12R30	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A12R31	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A12R32	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A12R33	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A12R34	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A12R35	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A12R36	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A12R37	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A12R38	0757-0482		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A12R39	0757-0482		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A12R40	0757-0465		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A12R41	[illegible]		[illegible]	[illegible]	[illegible]
A12R42*	[illegible]		[illegible]	[illegible]	[illegible]
A12R43	0757-0465		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A12R44	0698-3245		RESISTOR 20.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2052-F
A12R45*	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A12R46	0698-3441		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A12R47	0683-2425		RESISTOR 2.4K 5% .25W FC TC=-400/+700	01121	CB2425
A12R48	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A12R49	0683-3005		RESISTOR 30 5% .25W FC TC=-400/+500	01121	CB3005
A12R50	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A12R51	0683-6725		RESISTOR 6.7K 5% .25W FC TC=-400/+700	01121	CB6725
A12R52	0757-0465		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A12R53	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A12R54	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A12R55	0698-3245		RESISTOR 20.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2052-F
A12R56*	[illegible]		[illegible]	[illegible]	[illegible]
A12R57	[illegible]		[illegible]	[illegible]	[illegible]
A12R58	0698-3425		RESISTOR 1.58K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1581-F
A12R59*	0757-0454	1	RESISTOR 33.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3322-F
A12R60	0698-3540		RESISTOR 15.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1542-F
A12R61	0698-4425		RESISTOR 1.54K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1541-F
A12R62	0683-2425		RESISTOR 2.4K 5% .25W FC TC=-400/+700	01121	CB2425
A12R63	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A12R64	0683-3005		RESISTOR 30 5% .25W FC TC=-400/+500	01121	CB3005
A12R65	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A12R66	0683-6725		RESISTOR 6.7K 5% .25W FC TC=-400/+700	01121	CB6725
A12T1	9100-0825	2	TRANSFORMER:PULSE (TDK 11385)	28480	9100-0825
A12T2	9100-0827	2	TRANSFORMER:PULSE (TDK 512C1)	28480	9100-0827
A12T3	9100-0827		TRANSFORMER:PULSE (TDK 512C1)	28480	9100-0827
A12T4	9100-0825		TRANSFORMER:PULSE (TDK 11385)	28480	9100-0825
A13	04271-26525	1	PC BOARD BLANK	28480	04271-26525
A13	04271-66525	1	RESET & CLOCK PULSE GENERATOR ASSY	28480	04271-66525
A13C1	0180-2205		CAPACITOR-FXD 220PF +-5% 300VDC MICA	28480	0180-2205
A13C2	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A13C3	0180-1743	3	CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A13C4	0180-0100	1	CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A13C5	0180-1746	3	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A13C6	0180-1585	2	C:FXD MY 0.022 UF 5% 50VDC M	28480	0180-1585
A13C7	0180-1746		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A13C8	0180-1746		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A13C9	0180-1563	2	C:FXD MY 2200 PF 5% 50VDC M	28480	0180-1563
A13C10	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A13C11	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A13C12	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A13C13	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A13C14	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A13CR1	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A13CR2	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A13CR3	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A13CR4	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A13CR5	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A13CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A13CR7	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A13CR8	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A13CR9	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A13CR10	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8CR1 A8CR2	1901-0028 1901-0028	10	DIODE-SWP 5,111V 5% DO-7 POW,PW TC=+,009%	28480 28480	1901-0028 1901-0028
A8L1 A8L2 A8L3 A8L4	9100-1847 9100-1847 9100-1847 9100-1847	12	COIL-MLD 470UH 5% 0.65 ,100X,.46L6-HOM COIL-MLD 470UH 5% 0.65 ,100X,.46L6-HOM COIL-MLD 470UH 5% 0.65 ,100X,.46L6-HOM COIL-MLD 470UH 5% 0.65 ,100X,.46L6-HOM	28480 28480 28480 28480	9100-1847 9100-1847 9100-1847 9100-1847
A8Q1 A8Q2 A8Q3 A8Q4 A8Q5	1854-0071 1854-0064 1854-0064 1853-0020 1854-0064		TRANSISTOR PNP SI TO-18 TRANSISTOR NPN SI TRANSISTOR NPN SI TRANSISTOR PNP SI TO-106 TRANSISTOR NPN SI	28480 28480 28480	1854-0071 1854-0064 1853-0020 1854-0064
A8Q6 A8Q10 A8Q11	1854-0064 1853-0071 1853-0071		TRANSISTOR NPN SI TRANSISTOR PNP SI TRANSISTOR PNP SI	28480 01295 01295	1854-0064 SJ9013A SJ9013A
A8R1 A8R2 A8R3 A8R4 A8R5	0683-2715 0698-4116 0683-5135 0683-1045 0698-3153	13 2 10 13	RES-COMP 270 5% .25W FC TO-400-0000 RES-FILM 1.5K 1% .125W F TO-100-1500 RES-COMP 150 5% .25W FC TO-400-0000 RES-COMP 100K 5% .25W FC TO-400-0000 RES-FILM 2.37K 1% .125W F TO-100-2370	01121 28480 01121 01121 28480	27J5 0698-4116 CB1535 CB1045 0698-3153
A8R6 A8R7 A8R8 A8R9 A8R10	0757-0401 0683-1025 0683-0401 0683-3339 0698-3154	2 2 27	RES-FILM 100 1% .125W F TO-100-1000 RES-COMP 1K 5% .25W FC TO-400-0000 RES-COMP 100 5% .25W FC TO-400-0000 RES-FILM 3.48K 1% .125W F TO-100-3480 RES-FILM 2.61K 1% .125W F TO-100-2610	28480 01121 28480 28480 28480	0757-0401 CB1025 0683-0401 0698-3339 0698-3154
A8R11 A8R12 A8R13 A8R14 A8R15	0683-7535 0683-6225 0683-2335 0683-2435 0683-1015	2 5 11	RES-COMP 75K 5% .25W FC TO-400-0000 RES-COMP 2.2M 5% .25W FC TO-400-2200 RES-COMP 3.3K 5% .25W FC TO-400-0000 RES-COMP 3.4K 5% .25W FC TO-400-0000 RES-COMP 100K 5% .25W FC TO-400-0000	01121 01121 01121 01121 01121	CB7535 CB2225 CB3325 CB3425 CB1015
A8R17 A8R18 A8R19 A8R20 A8R21	0683-1005 0683-3615 0683-6215 0683-3315 0683-4725	2 2 4	RES-COMP 1M 5% .25W FC TO-400-0000 RES-COMP 360 5% .25W FC TO-400-0000 RES-COMP 620 5% .25W FC TO-400-0000 RES-COMP 330 5% .25W FC TO-400-0000 RES-COMP 4.7K 5% .25W FC TO-400-0000	01121 01121 01121 01121 01121	CB1005 CB3615 CB6215 CB3315 CB4725
A8R27 A8R28 A8R29 A8R30 A8R31	0683-1035 0683-1005 0683-4705 0683-1215 0683-1045		RES-COMP 10K 5% .25W FC TO-400-0000 RES-COMP 1M 5% .25W FC TO-400-0000 RES-COMP 47M 5% .25W FC TO-400-0000 RES-COMP 120 5% .25W FC TO-400-0000 RES-COMP 100K 5% .25W FC TO-400-0000	01121 01121 01121 01121 01121	CB1035 CB1005 CB4705 CB1215 CB1045
A8R32 A8R33 A8R34 A8R35 A8R36	0683-1035 0683-1025 0683-6215 0698-3155 0683-4725		RES-COMP 10K 5% .25W FC TO-400-0000 RES-COMP 1K 5% .25W FC TO-400-0000 RES-COMP 620 5% .25W FC TO-400-0000 RES-FILM 3.32K 1% .125W F TO-100-3320 RES-COMP 4.7K 5% .25W FC TO-400-0000	01121 01121 01121 28480 01121	CB1035 CB1025 CB6215 0698-3155 CB4725
A8R37 A8R38 A8R39 A8R40 A8R41 A8R42	0683-1035 0683-1005 0683-4705 0683-1215 0683-1045 0683-1045		RES-COMP 10K 5% .25W FC TO-400-0000 RES-COMP 1M 5% .25W FC TO-400-0000 RES-COMP 47M 5% .25W FC TO-400-0000 RES-COMP 120 5% .25W FC TO-400-0000 RES-COMP 100K 5% .25W FC TO-400-0000 RES-COMP 100K 5% .25W FC TO-400-0000	01121 01121 01121 01121 01121 01121	CB1035 CB1005 CB4705 CB1215 CB1045 CB1045
A8T1 A8T2 A8T3 A8T4	9100-0539 9100-0539 9100-0539 9100-0539		TRANSFORMER (T) TRANSFORMER (T) TRANSFORMER (T) TRANSFORMER (T)		
A8U2 A8U3	1826-0049 1826-0049	2	IC OPER AMPL TL-09 IC OPER AMPL TL-09	01295 01295	SN72709N SN72709N
A8 A8	08271-77208 08271-87208	1 2	C/L SYNCHRONOUS DETECTOR/INTEGRATOR ASSY PC BOARD BLANK ASSY	28480 28480	08271-77208 08271-87208
A8C1 A8C2 A8C3 A8C4 A8C5	0160-0127 0150-0121 0160-0127 0160-2960 0160-0939	6 8	CAPACITOR-FXD 1UF +-20% 25VDC CER CAPACITOR-FXD .1UF +80-20% 50VDC CER CAPACITOR-FXD 1UF +-20% 25VDC CER CAPACITOR-FXD .05UF +-20% 100VDC CER CAPACITOR-FXD 430PF +-5% 300VDC MICA	28480 28480 28480 28480 28480	0160-0127 0150-0121 0160-0127 0160-2960 0160-0939
A8C6 A8C7 A8C8 A8C9 A8C10	0150-0121 0150-0121 0160-1603 0150-0121 0150-0121	2	CAPACITOR-FXD .1UF +80-20% 50VDC CER CAPACITOR-FXD .1UF +80-20% 50VDC CER CAPACITOR-FXD MY 1 UF 10% 100VDC CAPACITOR-FXD .1UF +80-20% 50VDC CER CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480 28480 28480 28480 28480	0150-0121 0150-0121 0160-1603 0150-0121 0150-0121
A8C11 A8C12 A8C13 A8C15 A8C16	0150-0121 0150-0121 0150-0121 0160-3180 0150-0121	2	CAPACITOR-FXD .1UF +80-20% 50VDC CER CAPACITOR-FXD .1UF +80-20% 50VDC CER CAPACITOR-FXD .1UF +80-20% 50VDC CER CAPACITOR-FXD .068UF +-5% 100VDC POLYSTY CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480 28480 28480 84411 28480	0150-0121 0150-0121 0150-0121 663UW063J5%7 0150-0121
A8C17 A8C18 A8C19 A8C20 A8C21	0150-0121 0150-0121 0160-2960 0160-2960 0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER CAPACITOR-FXD .1UF +80-20% 50VDC CER CAPACITOR-FXD .05UF +-20% 100VDC CER CAPACITOR-FXD .05UF +-20% 100VDC CER CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480 28480 28480 28480 28480	0150-0121 0150-0121 0160-2960 0160-2960 0150-0121

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A13CR11	1902-0049		DIODE-ZNR 5.19V 5% DO-7 PD=.4W TC=+.022%	28480	1902-0049
A13CR12	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A13CR13	1902-0032	1	DIODE-ZNR 5.49V 5% DO-7 PD=.4W TC=+.009%	28480	1902-0032
A13L1	9140-0129		COIL-MLD 220UH 5% Q=45 .155DX.375LG-AXL	28480	9140-0129
A13L2	9140-0129		COIL-MLD 220UH 5% Q=45 .155DX.375LG-AXL	28480	9140-0129
A13Q1	1854-0214		TRANSISTOR NPN SI		
A13Q2	1854-0215		TRANSISTOR NPN SI		
A13Q3	1854-0215		TRANSISTOR NPN SI		
A13Q4	1854-0215		TRANSISTOR NPN SI		
A13Q5	1854-0215		TRANSISTOR NPN SI		
A13Q6	1854-0215		TRANSISTOR NPN SI		
A13Q7	1854-0215		TRANSISTOR NPN SI		
A13Q8	1854-0215		TRANSISTOR NPN SI		
A13Q9	1854-0215		TRANSISTOR NPN SI		
A13Q10	1854-0448	3	TRANSISTOR NPN SI TO-39 PD=1W FT=100MHZ	28480	1854-0448
A13R1	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R2	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R3	C698-3843	1	RESISTOR 178K 1% .125W F TC=0+-100	28546	C4=1/8-T0-1783-F
A13R4	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A13R5	0683-8225		RESISTOR 8.2K 5% .25W FC TC=-400/+700	01121	CB8225
A13R6	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB10-J
A13R7	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A13R8	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A13R9	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A13R10	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A13R11	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A13R12	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB27.9
A13R13	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A13R14	0683-8825		RESISTOR 8.8K 5% .25W FC TC=-400/+700	01121	CB8825
A13R15	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A13R16	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+800	01121	CB4715
A13R17	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A13R18	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A13R19	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A13R20	0757-0453	1	RESISTOR 30.1K 1% .125W F TC=0+-100	28546	C4=1/8-T0-3012-F
A13R21	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A13R22	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A13R23	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A13R24	0683-8825		RESISTOR 8.8K 5% .25W FC TC=-400/+700	01121	CB8825
A13R25	0683-8825		RESISTOR 8.8K 5% .25W FC TC=-400/+700	01121	CB8825
A13R26	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A13R27	0683-0275	3	RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB2705
A13R28	0683-7505	1	RESISTOR 75 5% .25W FC TC=-400/+500	01121	CB7505
A13R29	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A13U1	1820-0076	3	IC FF TTL J-K PULSE PRESET/CLEAR DUAL	01295	SN7476N
A13U2	1820-1197	27	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A13U3	1820-1144	14	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A13U4	1820-0071	5	IC BFR TTL NAND DUAL 4-INP	01295	SN7440N
A13U5	1820-1202	8	IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A13U6	1820-0371	1	IC GATE TTL H NAND TPL 3-INP	01295	SN74H10N
A13U7	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A13U8	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A13U9	1820-1112	8	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A13U10	1820-1202		IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A13U11	1820-0077	2	IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
A13U12	1820-0321		IC 710 COMPARATOR TO-99	01295	SN72710L
A14	04271-20520	1	PC BOARD BLANK	28480	04271-20520
A14	04271-66520	1	GATE&TRANSFER CONTROL ASSY	28480	04271-66520
A14C1	0180-1735	6	CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
A14C2	0180-0218	2	CAPACITOR-FXD .15UF+-10% 35VDC TA	56289	150D154X9035A2
A14C3	0160-1271		CAPACITOR-FXD MY 0.01 UF 5% 50VDC	28480	0160-1271
A14C4	0140-2205		CAPACITOR-FXD 120PF +-5% 300VDC MICA	28480	0140-2205
A14C5	0160-1583		CAPACITOR-FXD MY 2200 PF 5% 50VDC	28480	0160-1583
A14C6	0180-2075	1	CAPACITOR-FXD .047UF+-10% 35VDC TA	28480	0180-2075
A14C7	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A14C8	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A14C9	0160-0195	2	CAPACITOR-FXD 1000PF +-20% 250VAC(RMS)	28480	0160-0195
A14CR1	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A14CR2	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A14CR3	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A14Q1	1854-0215		TRANSISTOR NPN SI		

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6C22	0180-0181		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0180-0181
A6C23	0160-2055	4	CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
A6C24	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
A6C25	0180-0181		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0180-0181
A6C26	0180-0181		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0180-0181
A6C27	0180-0181		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0180-0181
A6C28	0180-0181		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0180-0181
A6C29					
A6CR1	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=+.057%	28480	1902-0041
A6CR2	1902-3164		DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	28480	1902-3164
A6CR3	1901-0040	28	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR4	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR5	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR7	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR8	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR9	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR10	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR11	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=+.057%	28480	1902-0041
A6L1	9100-1647		COIL-MLD ATOUM 5% 6MH ,190X,.4%LG=NOM	28480	9100-1647
A6L2	9100-1647		COIL-MLD ATOUM 5% 6MH ,190X,.4%LG=NOM	28480	9100-1647
A6L3	9100-1647		COIL-MLD ATOUM 5% 6MH ,190X,.4%LG=NOM	28480	9100-1647
A6L4	9100-1647		COIL-MLD ATOUM 5% 6MH ,190X,.4%LG=NOM	28480	9100-1647
A6Q1	1854-0854		TRANSISTOR NPN SI		
A6Q2	1855-0112	14	TSTR-FET (2N4393)	28480	1855-0112
A6Q3	1855-0112		TSTR-FET (2N4393)	28480	1855-0112
A6Q4	1855-0112		TSTR-FET (2N4393)	28480	1855-0112
A6Q5	1855-0112		TSTR-FET (2N4393)	28480	1855-0112
A6Q6	1854-0854		TRANSISTOR NPN SI		
A6Q7	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q8	1855-0112	2		28480	1855-0112
A6Q9	1855-0112		TSTR-FET (2N4393)	28480	1855-0112
A6Q10	1855-0112		TSTR-FET (2N4393)	28480	1855-0112
A6Q11	1855-0112		TSTR-FET (2N4393)	28480	1855-0112
A6Q12	1855-0112		TSTR-FET (2N4393)	28480	1855-0112
A6Q13	1855-0111	2		28480	1855-0111
A6Q14	1854-0854		TRANSISTOR NPN SI		
A6Q15	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q16	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q17	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q18	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q19	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q20	1854-0854		TRANSISTOR NPN SI		
A6R1	0683-1015		RESISTOR 100 5% ,25W FC TC=-400/+800	01121	CB1015
A6R2	0683-1025	2	RESISTOR 1,0K 5% ,25W FC TC=-400/+700	01121	CB1025
A6R3	0683-1005		RESISTOR 10 5% ,25W FC TC=-400/+800	01121	CB1005
A6R4	0698-3156	4	RESISTOR 1K,7K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A6R5	0698-3156		RESISTOR 1K,7K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A6R6	0757-0465	5	RESISTOR 100* 1% ,125W F TC=0+-100	24546	C4-1/8-T0-100*-F
A6R7	0698-3446	2	RESISTOR 383 1% ,125W F TC=0+-100	24546	C4-1/8-T0-383*-F
A6R8	0698-6088		RESISTOR 2,15K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A6R9	0683-1225	3	RESISTOR 1,2K 5% ,25W FC TC=-400/+700	01121	CB1225
A6R10	0683-2205	8	RESISTOR 22 5% ,25W FC TC=-400/+800	01121	CB2205
A6R11	0698-3158	2	RESISTOR 23,7K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-2372-F
A6R12	0757-0436	2	RESISTOR 3,65K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-3651-F
A6R13	0683-2435	12	RESISTOR 24K 5% ,25W FC TC=-400/+800	01121	CB2435
A6R14	0683-1535	10	RESISTOR 15K 5% ,25W FC TC=-400/+800	01121	CB1535
A6R15	0683-1045		RESISTOR 100* 5% ,25W FC TC=-400/+800	01121	CB1045
A6R16	0683-1025		RESISTOR 1K 5% ,25W FC TC=-400/+800	01121	CB1025
A6R17	0757-0442	9	RESISTOR 10K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R18	0757-0438		RESISTOR 5,11K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A6R19	0698-4020	2	RESISTOR 9,53K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-9531-F
A6R20	2100-1232		RESISTOR, VAR CERMET 1K 10% LIN 1/2W	28480	2100-1232
A6R21	0683-1045		RESISTOR 100K 5% ,25W FC TC=-400/+800	01121	CB1045
A6R22	0683-1045		RESISTOR 100K 5% ,25W FC TC=-400/+800	01121	CB1045
A6R23	0683-1045		RESISTOR 100K 5% ,25W FC TC=-400/+800	01121	CB1045
A6R24	0683-1045		RESISTOR 100K 5% ,25W FC TC=-400/+800	01121	CB1045
A6R25	0757-0440	4	RESISTOR 61,9K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A6R26	0757-0440		RESISTOR 61,9K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A6R27	0698-3160	2	RESISTOR 31,6K 1% ,125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A6R28	2100-3355	2	RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TRN	28480	2100-3355
A6R29	0683-1015		RESISTOR 100 5% ,25W FC TC=-400/+800	01121	CB1015
A6R30	0683-3325		RESISTOR 3,3K 5% ,25W FC TC=-400/+700	01121	CB3325
A6R31	0683-5105	10	RESISTOR 51 5% ,25W FC TC=-400/+800	01121	CB5105
A6R32	0683-1045		RESISTOR 100K 5% ,25W FC TC=-400/+800	01121	CB1045
A6R33	0683-2435		RESISTOR 24K 5% ,25W FC TC=-400/+800	01121	CB2435
A6R34	0683-1235		RESISTOR 12K 5% ,25W FC TC=-400/+800	01121	CB1235
A6R35	0683-2435		RESISTOR 24K 5% ,25W FC TC=-400/+800	01121	CB2435

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A14R1	0757-0289	1	RESISTOR 13.3K 1% .125W F TC=0+-100	19701	MFR1/8-T0-1332-F
A14R2	0683-3615		RESISTOR 360 5% .25W FC TC=-400/+600	01121	CB3615
A14R3	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A14R4	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A14R5	0683-2725		RESISTOR 2.7K 5% .25W FC TC=+400/+700	01121	CB2725
A14R6	0683-3925		RESISTOR 3.9K 5% .25W FC TC=+400/+700	01121	CB3925
A14R7	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A14U1	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A14U2	1820-1202		IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A14U3	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A14U4	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A14U5	1820-1202		IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A14U6	1820-0055	2	IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG	01295	SN74S90N
A14U7	1820-0055		IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG	01295	SN74S90N
A14U8	1820-0075	1	IC FF TTL J-K PULSE CLEAR DUAL	01295	SN7473N
A14U9	1820-1202		IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A14U10	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A14U11	1820-1112		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A14U12	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A14U13	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A14U14	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A14U15	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A14U16	1820-1202		IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A14U17	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A14U18	1820-0071		IC BFR TTL NAND DUAL 4-INP	01295	SN74H04N
A15	04271-26527	1	PC BOARD BLANK	28480	04271-26527
A15	04271-66527	1	STEP CONTROL ASSY	28480	04271-66527
A15C1	0180-0291		CAPACITOR-FXD 10UF+-10% 35VDC TA	56289	150D105X9035A2
A15C2	0180-0291		CAPACITOR-FXD 10UF+-10% 35VDC TA	56289	150D105X9035A2
A15CR1	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A15CR2	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A15R1	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A15R2	0683-3925		RESISTOR 3.9K 5% .25W FC TC=+400/+700	01121	CB3925
A15R3	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A15R4	0683-1225		RESISTOR 1.2K 5% .25W FC TC=+400/+700	01121	CB1225
A15R5	0683-5625		RESISTOR 5.6K 5% .25W FC TC=+400/+700	01121	CB5625
A15R6	0683-5625		RESISTOR 5.6K 5% .25W FC TC=+400/+700	01121	CB5625
A15R7	0683-2225		RESISTOR 2.2K 5% .25W FC TC=+400/+700	01121	CB2225
A15R8	0683-3925		RESISTOR 3.9K 5% .25W FC TC=+400/+700	01121	CB3925
A15U1	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A15U2	1820-1202		IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A15U3	1820-1112		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A15U4	1820-1112		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A15U5	1820-1112		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A15U6	1820-1112		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A15U7	1820-1112		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A15U8	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A15U9	1820-	4	[illegible]	[illegible]	[illegible]
A15U10	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A15U11	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A15U12	1820-1208	2	IC GATE TTL LS NAND DUAL 4-INP	01295	SN74LS20N
A15U13	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A15U14	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A15U15	1820-1200	1	IC INV TTL LS HEX	01295	SN74LS05N
A15U16	1820-		[illegible]	[illegible]	[illegible]
A15U17	1820-		[illegible]	[illegible]	[illegible]
A15U18	1820-		[illegible]	[illegible]	[illegible]
A15U19	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A15U20	1820-1287	1	IC BFR TTL LS NAND QUAD 2-INP	01295	SN74LS37N
A16	04271-26528	1	PC BOARD BLANK	28480	04271-26528
A16	04271-66528	1	FUNCTION&RANGE CONTROL ASSY	28480	04271-66528
A16C1	0180-0291		CAPACITOR-FXD 10UF+-10% 3 VDC TA	56289	150D105X9035A2
A16CR1	[illegible]		[illegible]	[illegible]	[illegible]
A16CR2	[illegible]		[illegible]	[illegible]	[illegible]
A16CR3	[illegible]		[illegible]	[illegible]	[illegible]
A16CR4	[illegible]		[illegible]	[illegible]	[illegible]
A16CR5	[illegible]		[illegible]	[illegible]	[illegible]
A16CR6	[illegible]		[illegible]	[illegible]	[illegible]
A16CR7	[illegible]		[illegible]	[illegible]	[illegible]
A16CR8	[illegible]		[illegible]	[illegible]	[illegible]
A16CR9	[illegible]		[illegible]	[illegible]	[illegible]
A16CR10	[illegible]		[illegible]	[illegible]	[illegible]

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8R18	0683-0155	1	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A8R19	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+800	01121	CB1525
A8R20	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+800	01121	CB1525
A8R21	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+800	01121	CB1525
A8R22	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+800	01121	CB1525
A8R23	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+800	01121	CB1525
A8R24	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A8R25	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+800	01121	CB1525
A8R26	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+800	01121	CB1525
A8R27	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+800	01121	CB1525
A8R28	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+800	01121	CB1525
A8R29	0683-0155		RESISTOR 1.5K 5% .25W FC TC=-400/+800	01121	CB1525
A8R30	0698-3155		RESISTOR 4.64K 1% .125W F TC=0+100	24546	C4-1/8-T0-4641-F
A8R31	0698-3155		RESISTOR 4.64K 1% .125W F TC=0+100	24546	C4-1/8-T0-4641-F
A8R32	0757-0472	2	RESISTOR 200K 1% .125W F TC=0+100	24546	C4-1/8-T0-2003-F
A8R33	2100-1234	1	RESISTOR, VAR CERMET 10K 10% LIN 1/2W	28480	2100-1234
A8R34	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+800	01121	CB1015
A8R35	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+800	01121	CB1015
A8R36	0683-2205		RESISTOR 22 5% .25W FC TC=-400/+800	01121	CB2205
A8R37	0683-2205		RESISTOR 22 5% .25W FC TC=-400/+800	01121	CB2205
A8R38	0683-1515	1	RESISTOR 150 5% .25W FC TC=-400/+800	01121	CB1515
A8T1	9100-0820		TRANSFORMER,PULSE	28480	9100-0820
A8T2	9100-0820		TRANSFORMER,PULSE	28480	9100-0820
A8U1	1820-0321	5	IC 710 COMPARATOR TO-99	01295	SN72710L
A8U2	1826-0319	2	IC OP AMP TO-99	27014	LF356H
A8U3	1826-0913	4	IC 741 OP AMP TO-99	06665	8087A1CJ
A8U4	1826-0909	2	IC 725 OP AMP TO-99	06665	8087Z5CJ
A8U5	1826-0913		IC 741 OP AMP TO-99	06665	8087A1CJ
A8U6	1820-0321		IC 710 COMPARATOR TO-99	01295	SN72710L
A9	0687-7720	1	S/R SYNCHRONOUS DETECTOR&INTEGRATOR ASSY	28480	0687-7720
A9	0687-8720		PC BOARD BLANK	28480	0687-8720
A9C1	0180-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0180-0127
A9C2	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C3	0180-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0180-0127
A9C4	0160-2940		CAPACITOR-FXD .05UF +-20% 100VDC CER	28480	0160-2940
A9C5	0180-0910		CAPACITOR-FXD 430PF +-5% 300VDC MICA	28480	0180-0910
A9C6	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C7	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C8	0160-1803		CAPACITOR-FXD .1 UF 10% 100VDCER	28480	0160-1803
A9C9	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C10	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C11	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C12	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C13	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C14	0160-3160		CAPACITOR-FXD .068UF +-5% 100VDC POLYSTY	84411	663UW-68391-M2
A9C15	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C16	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C17	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C18	0160-2940		CAPACITOR-FXD .05UF +-20% 100VDC CER	28480	0160-2940
A9C19	0160-2940		CAPACITOR-FXD .05UF +-20% 100VDC CER	28480	0160-2940
A9C20	0160-2940		CAPACITOR-FXD .05UF +-20% 100VDC CER	28480	0160-2940
A9C21	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C22	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C23	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C24	0160-2055		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C25	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C26	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C27	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C28	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C29	0160-2262	2	CAPACITOR-FXD 180PF +-5% 500VDC CER 0+-30	28480	0160-2262
A9CR1	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=+.010%	28480	1902-0041
A9CR2	1902-3149		DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	28480	1902-3149
A9CR3	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR4	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR5	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR7	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR8	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR9	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR10	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR11	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=+.009%	28480	1902-0041
A9L1	9100-1647		COIL-MLD 470UH 5% Q=45 ,190X,.44LG-.40W	28480	9100-1647
A9L2	9100-1647		COIL-MLD 470UH 5% Q=45 ,190X,.44LG-.40W	28480	9100-1647
A9L3	9100-1647		COIL-MLD 470UH 5% Q=45 ,190X,.44LG-.40W	28480	9100-1647
A9L4	9100-1647		COIL-MLD 470UH 5% Q=45 ,190X,.44LG-.40W	28480	9100-1647

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A16C11	[illegible]		[illegible]	[illegible]	[illegible]
A16C12	[illegible]		[illegible]	[illegible]	[illegible]
A16Q1	1854-0448		TRANSISTOR NPN SI TO-39 PD=1W FT=100MHZ	28480	1854-0448
A16Q2	1854-0448		TRANSISTOR NPN SI TO-39 PD=1W FT=100MHZ	28480	1854-0448
A16Q3	1854-0358	9	TRANSISTOR NPN SI TO-92 PD=360MW	28480	1854-0358
A16R1	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A16R2	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R3	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R4	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R5	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R6	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R7	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R8	0683-3925		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A16R9	0683-3925		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A16R10	0683-3925		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A16R11	0683-3925		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A16R12	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R13	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R14	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R15	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R16	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+800	01121	CB3915
A16R17	0683-3925		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A16R18	0683-3925		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A16R19	0683-3925		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A16R20	0683-3925		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A16R21	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A16R22	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A16R23	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A16R24	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A16R25	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A16R26	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A16R27	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A16R28	0683-2705		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A16R29	0683-2705		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A16R30	0683-5605	9	RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB56G5
A16U1	1820-0078		IC FF TTL J-K PULSE PRESET/CLEAR DUAL	01295	SN7476N
A16U2	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A16U3	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A16U4	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A16U5	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A16U6	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A16U7	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A16U8	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A16U9	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A16U10	1820-0054	21	IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A16U11	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A16U12	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A16U13	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A16U14	1820-0174	6	IC INV TTL HEX 1-INP	01295	SN7404N
A16U15	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A16U16	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A16U17	1820-0203	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
A17	04271-26529	1	PC BOARD BLANK	28480	04271-26529
A17	04271-66529	1	AUTO RANGE&LAMP DRIVER ASSY	28480	04271-66529
A17C1	0160-1548		C:FXD MY 4700 PF 5% 50VDCM	28480	0160-1548
A17C2	0180-0291		CAPACITOR-FXD ELP=+10% 35VDC TA	56289	150D105X0035A2
A17CR1	[illegible]		[illegible]	[illegible]	[illegible]
A17CR2	[illegible]		[illegible]	[illegible]	[illegible]
A17Q1	1854-0358		TRANSISTOR NPN SI TO-92 PD=360MW	28480	1854-0358
A17Q2	1854-0358		TRANSISTOR NPN SI TO-92 PD=360MW	28480	1854-0358
A17Q3	1854-0358		TRANSISTOR NPN SI TO-92 PD=360MW	28480	1854-0358
A17Q4	1854-0358		TRANSISTOR NPN SI TO-92 PD=360MW	28480	1854-0358
A17Q5	1854-0358		TRANSISTOR NPN SI TO-92 PD=360MW	28480	1854-0358
A17Q6	1854-0358		TRANSISTOR NPN SI TO-92 PD=360MW	28480	1854-0358
A17Q7	1854-0358		TRANSISTOR NPN SI TO-92 PD=360MW	28480	1854-0358
A17Q8	1854-0358		TRANSISTOR NPN SI TO-92 PD=360MW	28480	1854-0358
A17R1	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A17R2	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A17R3	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A17R4	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A17R5	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A7C1	1854-0064		TRANSISTOR NPN SI	28480	1854-0064
A7C2	1855-0012		TSTR:FET (2SK33A)	28480	1855-0012
A7C3	1855-0012		TSTR:FET (2SK33A)	28480	1855-0012
A7C4	1855-0012		TSTR:FET (2SK33A)	28480	1855-0012
A7C5	1855-0012		TSTR:FET (2SK33A)	28480	1855-0012
A7C6	1854-0064		TRANSISTOR NPN SI		
A7C7	1853-0020		TRANSISTOR PNP SI PD=300MW PT=150MHZ	28480	1853-0020
A7C8	1855-0012			28480	1855-0012
A7C9	1855-0012		TSTR:FET (2SK33A)	28480	1855-0012
A7C10	1855-0012		TSTR:FET (2SK33A)	28480	1855-0012
A7C11	1855-0012		TSTR:FET (2SK33A)	28480	1855-0012
A7C12	1855-0012		TSTR:FET (2SK33A)	28480	1855-0012
A7C13	1855-0111			28480	1855-0111
A7C14	1854-0064		TRANSISTOR NPN SI		
A7C15	1853-0020		TRANSISTOR PNP SI PD=300MW PT=150MHZ	28480	1853-0020
A7C16	1853-0020		TRANSISTOR PNP SI PD=300MW PT=150MHZ	28480	1853-0020
A7C17	1853-0020		TRANSISTOR PNP SI PD=300MW PT=150MHZ	28480	1853-0020
A7C18	1853-0020		TRANSISTOR PNP SI PD=300MW PT=150MHZ	28480	1853-0020
A7C19	1853-0020		TRANSISTOR PNP SI PD=300MW PT=150MHZ	28480	1853-0020
A7C20	1854-0064		TRANSISTOR NPN SI		
A7R1	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+800	01121	CB1015
A7R2	0683-1815		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1815
A7R3	0683-1005		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A7R4	2490-3156		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A7R5	2490-3156		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A7R6	0683-1221		RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1221
A7R7	0683-2201		RESISTOR 2.2K 5% .25W FC TC=-400/+500	01121	CB2201
A7R8	2490-3502	1	RESISTOR 80K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8002-F
A7R9	2490-3483		RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-T0-3830-F
A7R10	2490-3213		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A7R11	0683-2201		RESISTOR 2.2K 5% .25W FC TC=-400/+500	01121	CB2201
A7R12	2490-3172		RESISTOR 23.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2372-F
A7R13	2490-3883		RESISTOR 388K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3883-F
A7R14	0683-2435		RESISTOR 24K 5% .25W FC TC=-400/+800	01121	CB2435
A7R15	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A7R16	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A7R17	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A7R18	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A7R19	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R20	2490-4020		RESISTOR 9.53K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9531-F
A7R21	2100-1832		RESISTOR, VAR CERMET 1K 10% LIN 1/2W	28480	2100-1832
A7R22	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A7R23	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A7R24	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A7R25	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A7R26	0757-0440		RESISTOR 61.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A7R27	0757-0440		RESISTOR 61.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A7R28	0757-0442		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A7R29	2100-3355		RESISTOR-TRMR 100K 10% C BIDE-ADJ 1-TRN	28480	2100-3355
A7R30	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+800	01121	CB1015
A7R31	0683-3325		RESISTOR 3.3M 5% .25W FC TC=-400/+700	01121	CB3325
A7R32	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+800	01121	CB5105
A7R33	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A7R34	0683-2435		RESISTOR 24K 5% .25W FC TC=-400/+800	01121	CB2435
A7R35	0683-1235		RESISTOR 12K 5% .25W FC TC=-400/+800	01121	CB1235
A7R36	0683-2435		RESISTOR 24K 5% .25W FC TC=-400/+800	01121	CB2435
A7R37	0683-9125		RESISTOR 9.1K 5% .25W FC TC=-400/+700	01121	CB9125
A7R38	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A7R39	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A7R40	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A7R41	0683-2435		RESISTOR 24K 5% .25W FC TC=-400/+800	01121	CB2435
A7R42	0683-2435		RESISTOR 24K 5% .25W FC TC=-400/+800	01121	CB2435
A7R43	0683-9125		RESISTOR 9.1K 5% .25W FC TC=-400/+700	01121	CB9125
A7R44	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A7R45	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A7R46	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A7R47	2490-3168		RESISTOR 8.06K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8061-F
A7R48	2490-3166		RESISTOR 8.06K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8061-F
A7R49	0757-0472		RESISTOR 200K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2003-F
A7R50	2100-1834		RESISTOR, VAR CERMET 10K 10% LIN 1/2W	28480	2100-1834
A7R51	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+800	01121	CB1015
A7R52	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+800	01121	CB1015
A7R53	0683-2205		RESISTOR 22 5% .25W FC TC=-400/+500	01121	CB2205
A7R54	0683-2205		RESISTOR 22 5% .25W FC TC=-400/+500	01121	CB2205
A7R55	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+800	01121	CB1515

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A17R6	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A17R7	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A17R8	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A17R9	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A17R10	0683-0565		RESISTOR 5.6 5% .25W FC TC=-400/+500	01121	CB5605
A17R11	0683-0565		RESISTOR 5.6 5% .25W FC TC=-400/+500	01121	CB5605
A17R12	0683-0565		RESISTOR 5.6 5% .25W FC TC=-400/+500	01121	CB5605
A17R13	0683-0565		RESISTOR 5.6 5% .25W FC TC=-400/+500	01121	CB5605
A17R14	0683-0565		RESISTOR 5.6 5% .25W FC TC=-400/+500	01121	CB5605
A17R15	0683-0565		RESISTOR 5.6 5% .25W FC TC=-400/+500	01121	CB5605
A17R16	0683-0565		RESISTOR 5.6 5% .25W FC TC=-400/+500	01121	CB5605
A17R17	0683-0565		RESISTOR 5.6 5% .25W FC TC=-400/+500	01121	CB5605
A17U1	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A17U2	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A17U3	1820-0137		IC INV TTL HEX 1-INP	01295	SN7404N
A17U4	1820-1208		IC GATE TTL LS NAND DUAL 4-INP	01295	SN74LS20N
A17U5	1820-1199	11	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A17U6	1820-0072	10	IC GATE TTL AND-OR-INV DUAL 2-INP	01295	SN7450N
A17U7	1820-0072		IC GATE TTL AND-OR-INV DUAL 2-INP	01295	SN7450N
A17U8	1820-0072		IC GATE TTL AND-OR-INV DUAL 2-INP	01295	SN7450N
A17U9	1820-0076		IC FF TTL J-K PULSE PRESET/CLEAR DUAL	01295	SN7476N
A17U10	1820-1202		IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A17U11	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A17U12	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A17U13	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A17U14	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A18	04271-26530	1	PC BOARD BLANK	28480	04271-26530
A18	04271-66530	1	COUNTER ASSY	28480	04271-66530
A18C1	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A18C2	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A18C3	0160-0195		CAPACITOR-FXD 1000PF +-20% 250VAC(RMS)	28480	0160-0195
A18CR1	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A18CR2	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A18CR3	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A18CR4	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A18CR5	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A18CR6	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A18CR7	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A18CR8	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A18Q1	[illegible]		TRANSISTOR NPN SI		
A18R1	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+600	01121	CB3915
A18R2	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A18R3	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+600	01121	CB3335
A18R4	0683-3915		RESISTOR 390 5% .25W FC TC=-400/+600	01121	CB3915
A18R5	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A18R6	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A18R7	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A18U1	1820-1144		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A18U2	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A18U3	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A18U4	1820-1197		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A18U5	1820-0119	4	IC CNTR TTL DECD	28480	1820-0119
A18U6	1820-1199		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A18U7	1820-0119		IC CNTR TTL DECD	28480	1820-0119
A18U8	1820-1199		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A18U9	1820-0119		IC CNTR TTL DECD	28480	1820-0119
A18U10	1820-1199		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A18U11	1820-0119		IC CNTR TTL DECD	28480	1820-0119
A18U12	1820-1112		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A18U13	1820-1207	2	IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
A18U14	1820-1207		IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
A19	04271-26532	1	PC BOARD BLANK	28480	04271-26532
A19	04271-66532	1	DISPLAY ASSY	28480	04271-66532
A19C1	0180-1743		CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A19CR1	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A19CR2	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A7T1	9100-0880		TRANSFORMER,PULSE	28480	9100-0880
A7T2	9100-0880		TRANSFORMER,PULSE	28480	9100-0880
A7U1	1820-0321		IC 710 COMPARATOR TO-99	01295	SN72710L
A7U2	1826-0016		IC OP AMP TO-99	27014	LP356M
A7U3	1826-0013		IC 741 OP AMP TO-99	04713	SG7741CJ
A7U4	1826-0009		IC 725 OP AMP TO-99	04713	SG7725CJ
A7U5	1826-0013		IC 741 OP AMP TO-99	04713	SG7741CJ
A7U6	1820-0321		IC 710 COMPARATOR TO-99	01295	SN72710L
AB	08271-77210	1	MODULATOR ASSY	28480	08271-77210
AB	08271-87210	1	PC BOARD BLANK	28480	08271-87210
ABC1	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC2	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC3	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC4	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC5	0160-1987	2	CAPACITOR, FXD POLY 0.33 UF 5% 200VDC	28480	0160-1987
ABC6	0160-1987		CAPACITOR, FXD POLY 0.33 UF 5% 200VDC	28480	0160-1987
ABC7	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC8	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC10	0160-2206	3	CAPACITOR-FXD 180PF +-5% 300VDC MICA	28480	0160-2206
ABC11	0160-2206		CAPACITOR-FXD 180PF +-5% 300VDC MICA	28480	0160-2206
ABC12	0160-2206		CAPACITOR-FXD 180PF +-5% 300VDC MICA	28480	0160-2206
ABC13	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC15	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC16	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC17	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC18	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC19	0160-2264	8	CAPACITOR-FXD 22PF +-5% 500VDC CER 0+-30	28480	0160-2264
ABC20	0160-2307		CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
ABC21	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC22	0121-0105		CAPACITOR-V TRMR-CER 9-35PF 200V PC-MTG	91293	504135 9/35PF 5480
ABC23	0160-2203	2	CAPACITOR-FXD 91PF +-5% 300VDC MICA 0+70	28480	0160-2203
ABC24	0160-2264	1	CAPACITOR-FXD 22PF +-5% 500VDC CER 0+-30	28480	0160-2264
ABC25	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC26	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC27	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC28	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC29	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC30	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC31	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC32	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC33	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC34	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC35	0160-2264		CAPACITOR-FXD 22PF +-5% 500VDC CER 0+-30	28480	0160-2264
ABC36	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
ABC37	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
ABC38	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
ABC39	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
ABC40	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC41	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC42	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABC43	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC44	0150-0121		CAPACITOR-FXD ,1UF +80-20% 50VDC CER	28480	0150-0121
ABC45	0160-2055		CAPACITOR-FXD ,01UF +80-20% 100VDC CER	28480	0160-2055
ABCR1	1902-0064	8	DIODE-ZNR 7.5V 5% DO-7 PD=.4W TC=+.05%	28480	1902-0064
ABCR2	1910-0016		DIODE-GE 1 N 4 6 4	28480	1910-0016
ABCR3	1910-0016		DIODE-GE 1 N 4 6 4	28480	1910-0016
ABL1	9140-0129	23	COIL-MLD 220UH 5% Q=45 ,159DX,375LG-HOR	28480	9140-0129
ABQ1	1855-0091	8	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
ABQ2	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
ABQ3	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
ABQ4	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
ABQ5	1854-0064		TRANSISTOR NPN SI		
ABQ6	1854-0064		TRANSISTOR NPN SI		
ABQ7	1854-0064		TRANSISTOR NPN SI		
ABQ8	1854-0064		TRANSISTOR NPN SI		
ABQ9	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
ABQ11	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
ABQ12	1854-0064		TRANSISTOR NPN SI		
ABQ13	1854-0064		TRANSISTOR NPN SI		
ABQ14	1854-0064		TRANSISTOR NPN SI		
ABQ15	1854-0064		TRANSISTOR NPN SI		
ABQ16	1854-0064		TRANSISTOR NPN SI		

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A19DS1	1990-0329	10	DISPLAY-NUM DOT MAT 1-CHAR .29in	28480	5082-7300
A19DS2	1990-0329		DISPLAY-NUM DOT MAT 1-CHAR .29in	28480	5082-7300
A19DS3	1990-0329		DISPLAY-NUM DOT MAT 1-CHAR .29in	28480	5082-7300
A19DS4	1990-0329		DISPLAY-NUM DOT MAT 1-CHAR .29in	28480	5082-7300
A19DS5	1990-0329		DISPLAY-NUM DOT MAT 1-CHAR .29in	28480	5082-7300
A19DS6	1990-0329		DISPLAY-NUM DOT MAT 1-CHAR .29in	28480	5082-7300
A19DS7	1990-0329		DISPLAY-NUM DOT MAT 1-CHAR .29in	28480	5082-7300
A19DS8	1990-0329		DISPLAY-NUM DOT MAT 1-CHAR .29in	28480	5082-7300
A19DS9	1990-0329		DISPLAY-NUM DOT MAT 1-CHAR .29in	28480	5082-7300
A19DS10	1990-0329		DISPLAY-NUM DOT MAT 1-CHAR .29in	28480	5082-7300
A19DS11	2140-0132	19		28480	2140-0132
A19DS12	2140-0132			28480	2140-0132
A19DS13	2140-0132			28480	2140-0132
A19DS14	2140-0132			28480	2140-0132
A19DS15	2140-0132			28480	2140-0132
A19DS16	2140-0132			28480	2140-0132
A19DS17	2140-0132			28480	2140-0132
A19DS18	2140-0132			28480	2140-0132
A19DS19	2140-0132			28480	2140-0132
A19DS20	2140-0132			28480	2140-0132
A19DS21	2140-0132			28480	2140-0132
A19DS22	2140-0132			28480	2140-0132
A19DS23	2140-0132			28480	2140-0132
A19DS24	2140-0132			28480	2140-0132
A19DS25	2140-0132			28480	2140-0132
A19DS26	1990-0404	1	LED-VISIBLE LUM-INTM300UCD IF=30MA-MAX	28480	5082-4480
A19DS27	2140-0132			28480	2140-0132
A19DS28	2140-0132			28480	2140-0132
A19DS29	2140-0132			28480	2140-0132
A19DS30	2140-0132			28480	2140-0132
A19R1	0683-3315		RESISTOR 330 5% .25W FC TC=-400/+800	01121	CB3315
A19R2	0683-1025		RESISTOR 1M 5% .25W FC TC=-400/+800	01121	CB1025
A20	04271-60001	1	OFFSET ADJ ASSY	28480	04271-60001
A20R1	2100-1443	2	RESISTOR-VAR PREC MM 10-TRN 50K 1%	28480	2100-1443
A20R2	2100-2035	2	RESISTOR-VAR CONTRCL CCP 50K 20% LIN	28480	2100-2035
A20R3	2100-1443		RESISTOR-VAR PREC MM 10-TRN 50K 1%	28480	2100-1443
A20R4	2100-2035		RESISTOR-VAR CONTRCL CCP 50K 20% LIN	28480	2100-2035
A21	04271-77227	1	DC BIAS SUPPLY(CPT, 001)	28480	04271-77227
A21	04271-87227	1	PC BOARD BLANK	28480	04271-87227
A21C1	0180-1548		CAPCD MY 6700 PF 5% 50VDCM	28480	0180-1548
A21CR1	1902-0777		DIODE-ZNR 1N825 6.2V 5% DO-7 PD=.4W	04713	1N825
A21CR2	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21CR3	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A21CR4	[illegible]		[illegible]	28480	[illegible]
A21Q1	[illegible]		TRANSISTOR NPN SI		
A21Q2	[illegible]		TRANSISTOR NPN SI		
A21Q3	[illegible]		TRANSISTOR NPN SI		
A21Q4	[illegible]		TRANSISTOR NPN SI		
A21Q5	[illegible]		TRANSISTOR NPN SI		
A21Q6	[illegible]		TRANSISTOR NPN SI		
A21Q7	[illegible]		TRANSISTOR NPN SI		
A21Q8	[illegible]		TRANSISTOR NPN SI		
A21Q9	[illegible]		TRANSISTOR NPN SI		
A21Q10	[illegible]		TRANSISTOR NPN SI		
A21Q11	[illegible]		TRANSISTOR NPN SI		
A21Q12	[illegible]		TRANSISTOR NPN SI		
A21Q13	[illegible]		TRANSISTOR NPN SI		
A21Q14	[illegible]		TRANSISTOR NPN SI		
A21Q15	[illegible]		TRANSISTOR NPN SI		
A21Q16	[illegible]		TRANSISTOR NPN SI		
A21Q17	[illegible]		TRANSISTOR NPN SI		
A21Q18	[illegible]		TRANSISTOR NPN SI		
A21Q19	[illegible]		TRANSISTOR NPN SI		
A21Q20	[illegible]		TRANSISTOR NPN SI		
A21Q21	[illegible]		TRANSISTOR NPN SI		
A21Q22	[illegible]		TRANSISTOR NPN SI		
A21Q23	[illegible]		TRANSISTOR NPN SI		
A21Q24	[illegible]		TRANSISTOR NPN SI		
A21Q25	[illegible]		TRANSISTOR NPN SI		
A21Q26	[illegible]		TRANSISTOR NPN SI		
A21Q27	[illegible]		TRANSISTOR NPN SI		
A21Q28	[illegible]		TRANSISTOR NPN SI		
A21Q29	[illegible]		TRANSISTOR NPN SI		
A21Q30	[illegible]		TRANSISTOR NPN SI		

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8Q17	1854-0864		TRANSISTOR NPN SI		
A8Q18	1853-0070		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0070
A8Q19	1853-0070		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0070
A8R1	0698-3328		RESISTOR 2.3K 1% .25W FC TC=+100/+700	01121	CB2321
A8R2	0698-3328		RESISTOR 2.3K 1% .25W FC TC=+100/+700	01121	CB2321
A8R3	0698-3328		RESISTOR 2.3K 1% .25W FC TC=+100/+700	01121	CB2321
A8R4	0698-3328		RESISTOR 2.3K 1% .25W FC TC=+100/+700	01121	CB2321
A8R5	0698-1048		RESISTOR 100K 1% .25W FC TC=+100/+800	01121	CB1041
A8R6	0698-1048		RESISTOR 100K 1% .25W FC TC=+100/+800	01121	CB1041
A8R7	0698-1048		RESISTOR 100K 1% .25W FC TC=+100/+800	01121	CB1041
A8R8	0698-1048		RESISTOR 100K 1% .25W FC TC=+100/+800	01121	CB1041
A8R9	2100-2031	8	RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	73138	82PR50K
A8R10	2100-2031		RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	73138	82PR50K
A8R11	2100-2031		RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	73138	82PR50K
A8R12	2100-2031		RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	73138	82PR50K
A8R13	0698-3328		RESISTOR 2.3K 1% .25W FC TC=+100/+700	01121	CB2321
A8R14	0698-2655	2	RESISTOR 2.49K 1% .25W FC TC=+100/+1100	01121	CB2491
A8R15	2100-3398	3	RESISTOR-TRMR 50K 10% C SIDE-ADJ 1-TRN	28480	2100-3398
A8R16	0698-3328		RESISTOR 2.3K 1% .25W FC TC=+100/+700	01121	CB2321
A8R17	0698-2655		RESISTOR 2.49K 1% .25W FC TC=+100/+1100	01121	CB2491
A8R18	2100-3398		RESISTOR-TRMR 50K 10% C SIDE-ADJ 1-TRN	28480	2100-3398
A8R19	0698-1015		RESISTOR 100 1% .25W FC TC=+100/+800	01121	CB1015
A8R20	0698-1015		RESISTOR 100 1% .25W FC TC=+100/+800	01121	CB1015
A8R21	0698-1035		RESISTOR 10K 1% .25W FC TC=+100/+700	01121	CB1035
A8R22	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	28480	C4-1/8-T0-1001-F
A8R23	0698-2225		RESISTOR 2.2K 1% .25W FC TC=+100/+700	01121	CB2225
A8R24	0698-1325	8	RESISTOR 1.5K 1% .25W FC TC=+100/+700	01121	CB1525
A8R25	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	28480	C4-1/8-T0-1001-F
A8R26	0698-1325		RESISTOR 1.5K 1% .25W FC TC=+100/+700	01121	CB1525
A8R27	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	28480	C4-1/8-T0-1001-F
A8R28	0698-1325		RESISTOR 1.5K 1% .25W FC TC=+100/+700	01121	CB1525
A8R29	0698-1045		RESISTOR 100K 1% .25W FC TC=+100/+800	01121	CB1041
A8R30	0757-0405	2	RESISTOR 162 1% .125W F TC=0+-100	28480	C4-1/8-T0-162R-F
A8R32	0757-0405		RESISTOR 162 1% .125W F TC=0+-100	28480	C4-1/8-T0-162R-F
A8R33	0698-1045		RESISTOR 100K 1% .25W FC TC=+100/+800	01121	CB1041
A8R34	0757-0416	3	RESISTOR 511 1% .125W F TC=0+-100	28480	C4-1/8-T0-511R-F
A8R35	0757-0410	1	RESISTOR 332 1% .125W F TC=0+-100	28480	C4-1/8-T0-332R-F
A8R37	0698-2725	14	RESISTOR 2.7K 5% .25W FC TC=+400/+700	01121	CB2725
A8R38	0698-2705	1	RESISTOR 27 5% .25W FC TC=+400/+800	01121	CB2705
A8R39	0698-5125		RESISTOR 5.1K 5% .25W FC TC=+400/+700	01121	CB5125
A8R40	0698-2025		RESISTOR 2K 5% .25W FC TC=+400/+700	01121	CB2025
A8R41	0757-0433	1	RESISTOR 3.32K 1% .125W F TC=0+-100	28480	C4-1/8-T0-3321-F
A8R42	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	28480	C4-1/8-T0-5111-F
A8R43	0698-1015		RESISTOR 100 5% .25W FC TC=+400/+800	01121	CB1015
A8R44	0698-2225		RESISTOR 2.2K 5% .25W FC TC=+400/+700	01121	CB2225
A8R47*	0757-0442	2	RESISTOR 750 1% .125W F TC=0+-100	28480	C4-1/8-T0-751-F
A8R48	0698-2725		RESISTOR 2.7K 5% .25W FC TC=+400/+700	01121	CB2725
A8R49	0698-1015		RESISTOR 100 5% .25W FC TC=+400/+800	01121	CB1015
A8R50	0698-5125		RESISTOR 5.1K 5% .25W FC TC=+400/+700	01121	CB5125
A8R51	0757-0440		RESISTOR 7.5K 1% .125W F TC=0+-100	28480	C4-1/8-T0-7501-F
A8R52	0698-2225		RESISTOR 2.2K 5% .25W FC TC=+400/+700	01121	CB2225
A8R53	0698-0084		RESISTOR 2.15K 1% .125W F TC=0+-100	28480	C4-1/8-T0-2151-F
A8R54	0757-0397	2	RESISTOR 68.1 1% .125W F TC=0+-100	28480	C4-1/8-T0-68R1-F
A8R55	0698-1015		RESISTOR 100 5% .25W FC TC=+400/+500	01121	CB1015
A8R56	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	28480	C4-1/8-T0-1002-F
A8R58	0698-2025		RESISTOR 2K 5% .25W FC TC=+400/+700	01121	CB2025
A8R61	0698-2235	6	RESISTOR 22K 5% .25W FC TC=+400/+800	01121	CB2235
A8R62	0698-5625		RESISTOR 5.6K 5% .25W FC TC=+400/+700	01121	CB5625
A8R63	0698-5105		RESISTOR 51 5% .25W FC TC=+400/+500	01121	CB5105
A8R64	0698-5105		RESISTOR 51 5% .25W FC TC=+400/+500	01121	CB5105
A8R65	0698-1005		RESISTOR 10 5% .25W FC TC=+400/+500	01121	CB1005
A8R66	0698-1005		RESISTOR 10 5% .25W FC TC=+400/+500	01121	CB1005
A8T1	9100-0823	5	TRANSFORMER(TOK 113B1) 11111	28480	9100-0823
A8T2	9100-0833	2	TRANSFORMER (TOK 133E1)11313	28480	9100-0833
A8T3	9100-0833		TRANSFORMER (TOK 133E1)11313	28480	9100-0833
A8T4	9100-0826	1	TRANSFORMER,PULSE	28480	9100-0826
A8T5	9100-0826	1	TRANSFORMER(TOK 312C1) 41111	28480	9100-0826
A8T7	9100-0826		TRANSFORMER(TOK 312C1) 41111	28480	9100-0826
A8U1	1820-0203		IC 741 OP AMP TO-99	01928	CA741CT
A8U2	1820-0203		IC 741 OP AMP TO-99	01928	CA741CT
A9	04271-77211	1	POWER AMPLIFIER ASSY	28480	04271-77211
A9	04271-87211	1	PC BOARD BLANK	28480	04271-87211

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A21C31	[illegible]		TRANSISTOR NPN SI		
A21C32	[illegible]		TRANSISTOR NPN SI		
A21C33	[illegible]		TRANSISTOR NPN SI		
A21C34	[illegible]		TRANSISTOR NPN SI		
A21C35	[illegible]		TRANSISTOR NPN SI		
A21C36	[illegible]		TRANSISTOR NPN SI		
A21C37	[illegible]		TRANSISTOR NPN SI		
A21C38	[illegible]		TRANSISTOR NPN SI		
A21C39	[illegible]		TRANSISTOR NPN SI		
A21C40	[illegible]		TRANSISTOR NPN SI		
A21C41	[illegible]		TRANSISTOR NPN SI		
A21C42	[illegible]	1	TRANSISTOR NPN SI TO-39 PD=1W FT=150MHZ	28480	1854-0232
A21C43	[illegible]		TRANSISTOR NPN SI		
A21R1	0698-2195	2	RESISTOR MET FLM 400K OHM 0.25% 1/8W	28480	0698-2195
A21R2	0698-2196	3	RESISTOR MET FLM 200K OHM 0.25% 1/8W	28480	0698-2196
A21R3	0698-2197	2	RESISTOR MET FLM 100K OHM 0.1% 1/8W	28480	0698-2197
A21R4	0698-2198	2	RESISTOR MET FLM 50K OHM 0.1% 1/8W	28480	0698-2198
A21R5	0698-2203	1	RESISTOR MET FLM 261,3K OHM 0.25% 1/8W	28480	0698-2203
A21R6	0698-2195		RESISTOR MET FLM 400K OHM 0.25% 1/8W	28480	0698-2195
A21R7	2100-1233		RESISTOR, VAR FLM 5K OHM 10% LIN 1/2W	28480	2100-1233
A21R8	0698-2196		RESISTOR MET FLM 200K OHM 0.25% 1/8W	28480	0698-2196
A21R9	2100-2521	1	RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	30983	ET50X202
A21R10	0698-2197		RESISTOR MET FLM 100K OHM 0.1% 1/8W	28480	0698-2197
A21R11	2100-1232		RESISTOR, VAR CERMET 1K 10% LIN 1/2W	28480	2100-1232
A21R12	0698-2198		RESISTOR MET FLM 50K OHM 0.1% 1/8W	28480	0698-2198
A21R13	2100-2574		RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	30983	ET50X501
A21R14	0698-2199	1	RESISTOR MET FLM 40K OHM 0.1% 1/8W	28480	0698-2199
A21R15	2100-2574		RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	30983	ET50X501
A21R16	0698-2200	1	RESISTOR MET FLM 20K OHM 0.1% 1/8W	28480	0698-2200
A21R17	2100-1231	1		28480	2100-1231
A21R18	0698-2201	1	RESISTOR MET FLM 10K OHM 0.25% 1/8W	28480	0698-2201
A21R19	0757-0419		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-6810-F
A21R20	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A21R21	2100-2705	1	RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-102
A21R22	0698-3515		RESISTOR 5.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5901-F
A21R23	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A21R24	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A21R25	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A21R26	0683-5125		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A21R27	0698-2202	1	RESISTOR MET FLM 25K OHM 0.25% 1/8W	28480	0698-2202
A21R28	0698-2196		RESISTOR MET FLM 200K OHM 0.25% 1/8W	28480	0698-2196
A21R29	0698-3245		RESISTOR 20.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2052-F
A21R30	0757-0470	1	RESISTOR 182K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1823-F
A21R32	2100-2503	1	RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-203
A21R34	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A21R35	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R36	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A21R37	0686-5125		RESISTOR 5.1K 5% .5W CC TC=0+847	01121	EB5125
A21R38	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A21R39	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R40	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R41	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R42	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R43	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R44	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R45	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R46	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R47	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R48	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R49	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R50	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R51	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R52	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R53	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R54	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R55	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R56	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R57	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R58	0683-3935		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A21R59	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R60	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R61	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R62	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R63	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R64	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R65	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R66	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R67	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A9C1	0180-0283	3	CAPACITOR-FXD 180PF +-5% 300VDC CER 0+-30	28480	0180-0283
A9C2	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C3	0180-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0180-0127
A9C4	0180-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0180-0127
A9C5	0180-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0180-0127
A9C6	0180-0163	1	CAPACITOR-FXD .033UF +-10% 200VDC POLYE	28480	0180-0163
A9C7	0180-1548	2	CAPACITOR-FXD MY 0.1% UF 10% 200VDCM	28480	0180-1548
A9C8	0180-1548		CAPACITOR-FXD MY 0.1% UF 10% 200VDCM	28480	0180-1548
A9C9	0180-0283		CAPACITOR-FXD 180PF +-5% 300VDC CER 0+-30	28480	0180-0283
A9C10	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A9C11	0180-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0180-0127
A9C12	0180-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0180-0127
A9C13	0180-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0180-0127
A9C14	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A9C15	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A9C16	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A9C17	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A9C18	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A9CR1	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR2	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR3	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR4	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR5	1901-0028	13	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0028
A9CR6	1902-0064		DIODE-ZNR 7.5V 5% DO-7 PD=.4W TC=+.05%	28480	1902-0064
A9J1	1250-0257	8	CONNECTOR-RF BNC M PC 50-OHM	28480	1250-0257
A9J2	1250-0257		CONNECTOR-RF BNC M PC 50-OHM	28480	1250-0257
A9J3	1250-0257		CONNECTOR-RF BNC M PC 50-OHM	28480	1250-0257
A9K1	0490-0234	7	RELAY, REED	28480	0490-0234
A9K2	0490-0234		RELAY, REED	28480	0490-0234
A9K3	0490-0234		RELAY, REED	28480	0490-0234
A9L1	9140-0210		COIL-MLD 100UH 5% Q=50 .155DX.375LG-NOM	28480	9140-0210
A9L2	9140-0210		COIL-MLD 100UH 5% Q=50 .155DX.375LG-NOM	28480	9140-0210
A9L3	9140-0137	8	COIL-MLD 1MH 5% Q=80 .191DX.844LG-NOM	28480	9140-0137
A9L4	9140-0137		COIL-MLD 1MH 5% Q=80 .191DX.844LG-NOM	28480	9140-0137
A9L5	9140-0210		COIL-MLD 100UH 5% Q=50 .155DX.375LG-NOM	28480	9140-0210
A9L6	9140-0210		COIL-MLD 100UH 5% Q=50 .155DX.375LG-NOM	28480	9140-0210
A9L7	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-NOM	28480	9140-0129
A9L8	9140-0129		COIL-MLD 220UH 5% Q=65 .155DX.375LG-NOM	28480	9140-0129
A9Q1	1854-0054		TRANSISTOR NPN SI		
A9Q2	1854-0054		TRANSISTOR NPN SI		
A9Q3	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A9Q4	1854-0054		TRANSISTOR NPN SI		
A9Q5	1854-0013	2	TRANSISTOR NPN 2N2218A SI TO-5 PD=800MW	04713	2N2218A
A9Q6	1853-0012		TRANSISTOR PNP 2N2904A SI TC=.39 PD=600MW	01295	2N2904A
A9Q7	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A9Q8	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A9Q9	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A9Q10	1854-0054		TRANSISTOR NPN SI		
A9Q11	1854-0054		TRANSISTOR NPN SI		
A9Q12	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A9Q13	1854-0054		TRANSISTOR NPN SI		
A9Q14	1854-0013		TRANSISTOR NPN 2N2218A SI TO-5 PD=800MW	04713	2N2218A
A9Q15	1853-0012		TRANSISTOR PNP 2N2904A SI TC=.39 PD=600MW	01295	2N2904A
A9Q16	1854-0054		TRANSISTOR NPN SI		
A9Q17	1854-0054		TRANSISTOR NPN SI		
A9Q18	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A9Q19	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A9Q20	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A9R1	0683-5635		RESISTOR 5.6K 5% .25W FC TC=+400/+700	01121	CB5625
A9R2	0683-2025		RESISTOR 2K 5% .25W FC TC=+400/+700	01121	CB2025
A9R3	0683-1015		RESISTOR 100 5% .25W FC TC=+400/+500	01121	CB1015
A9R4	0683-1015		RESISTOR 100 5% .25W FC TC=+400/+500	01121	CB1015
A9R5	0683-2225		RESISTOR 2.2K 5% .25W FC TC=+400/+700	01121	CB2225
A9R6	0683-2015	2	RESISTOR 200 5% .25W FC TC=+400/+600	01121	CB2015
A9R7	0683-3365	2	RESISTOR 3.3K 5% .25W FC TC=+400/+500	01121	CB3365
A9R8	0683-2725		RESISTOR 2.7K 5% .25W FC TC=+400/+700	01121	CB2725
A9R9	0698-0085	2	RESISTOR 2.61K 1% .125W F TC=0+-100	28480	CA-1/8-T0-2611-F
A9R10	0683-0515	4	RESISTOR 5.1 5% .25W FC TC=+400/+500	01121	CB5105
A9R11	0683-0515		RESISTOR 5.1 5% .25W FC TC=+400/+500	01121	CB5105
A9R12	0757-1094	4	RESISTOR 1.47K 1% .125W F TC=0+-100	28480	CA-1/8-T0-1471-F
A9R13	0757-1094		RESISTOR 1.47K 1% .125W F TC=0+-100	28480	CA-1/8-T0-1471-F
A9R14	0683-0475	1	RESISTOR 4.7 5% .25W FC TC=+400/+500	01121	CB4705
A9R15	0698-3435	1	RESISTOR 38.3 1% .125W F TC=0+-100	28480	CA-1/8-T0-38R3-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A21R68	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R69	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R70	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R71	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R72	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R73	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R74	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R75	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R76	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R77	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R78	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A21R79	0683-1215		RESISTOR 120 5% .25W FC TC=-400/+800	01121	CB1215
A21R80	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A21R81	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R82	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R83	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R84	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R85	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R86	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R87	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R88	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R89	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R90	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R91	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R92	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R93	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R94	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R95	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R96	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R97	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R98	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R99	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R100	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21U1	1820-0203		IC 741 OP AMP TO-99	01928	CA741CT
A21U2	1820-0203		IC 741 OP AMP TO-99	01928	CA741CT
A21U3	1820-0203		IC 741 OP AMP TO-99	01928	CA741CT
A21U4	1820-0876	3	IC LCH TTL L D-TYPE 4-BIT	01295	SN74L75N
A21U5	1820-0876		IC LCH TTL L D-TYPE 4-BIT	01295	SN74L75N
A21U6	1820-0876		IC LCH TTL L D-TYPE 4-BIT	01295	SN74L75N
A22			NOT ASSIGNED		
A23	04271-77229	1	C/L BCD OUTPUT ASSY(OPT. 002)	28480	04271-77229
A23	04271-87229	1	PC BOARD BLANK	28480	04271-87229
A23C1	0160-1271		CAPACITOR-FXD MY 0.01 UF 5% 50VDCM	28480	0160-1271
A23C2	0180-1735		CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
A23C3	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A23C4	0140-0195	3	CAPACITOR-FXD 130PF +-5% 300VDC MICA	72136	DM15F131J0300WV1CR
A23Q1	1854-0054		TRANSISTOR NPN SI		
A23Q2	1854-0054		TRANSISTOR NPN SI		
A23R1	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A23R2	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A23R3	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A23R4	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+800	01121	CB4715
A23R5	0683-2735		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A23R6	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A23R7	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A23R8	0683-5635	1	RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A23U1	1820-0301	15	IC LCH TTL D-TYPE 4-BIT	01295	SN74175N
A23U2	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN74175N
A23U3	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN74175N
A23U4	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN74175N
A23U5	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN74175N
A23U6	1820-0071		IC BFR TTL NAND DUAL 4-INP	01295	SN7440N
A23U7	1820-0176		IC INV TTL HEX 1-INP	01295	SN7404N
A23U8	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A23U9	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A23U10	1820-0176		IC INV TTL HEX 1-INP	01295	SN7404N
A23U11	1820-0072		IC GATE TTL AND-OR-INV DUAL 2-INP	01295	SN7450N
A23U12	1820-0072		IC GATE TTL AND-OR-INV DUAL 2-INP	01295	SN7450N

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A9R16	0698-0082	1	RESISTOR 464 1% .125W F TC=0+-100	28480	C4=1/8=T0=4640=F
A9R17	0757-0420		RESISTOR 750 1% .125W F TC=0+-100	28480	C4=1/8=T0=7501=F
A9R18	0683-5115	4	RESISTOR 510 5% .25W FC TC=-400/+800	01121	CB5115
A9R19	0683-5115	1	RESISTOR 510 5% .25W FC TC=-400/+800	01121	CB5115
A9R20	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+800	01121	CB5115
A9R21	0683-4715	6	RESISTOR 470 5% .25W FC TC=-400/+800	01121	CB4715
A9R22	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+800	01121	CB4715
A9R23	0683-3685		RESISTOR 6.8K 5% .25W FC TC=-400/+700	01121	CB6885
A9R24	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A9R27	0683-1015		RESISTOR 100 1% .25W FC TC=-400/+800	01121	CB1015
A9R28	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+800	01121	CB1015
A9R29	0683-6225		RESISTOR 6.2K 5% .25W FC TC=-400/+700	01121	CB6225
A9R30	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+800	01121	CB2015
A9R31	0683-3165		RESISTOR 3.6 5% .25W FC TC=-400/+800	01121	CB3665
A9R32	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A9R33	0698-0085		RESISTOR 2.61K 1% .125W F TC=0+-100	28480	C4=1/8=T0=2611=F
A9R34	0683-0515		RESISTOR 5.1 5% .25W FC TC=-400/+800	01121	CB5165
A9R35	0683-0515		RESISTOR 5.1 5% .25W FC TC=-400/+800	01121	CB5165
A9R36	0757-1094		RESISTOR 1.47K 1% .125W F TC=0+-100	28480	C4=1/8=T0=1471=F
A9R37	0757-1094		RESISTOR 1.47K 1% .125W F TC=0+-100	28480	C4=1/8=T0=1471=F
A9R38	0683-3935	22	RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A9R39	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A9R40	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A9R41	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A9R42	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A9R43	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A9R44	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A9T1	9100-0821	2	TRANSFORMER,PULSE (SEE A9T3)	28480	9100-0821
A9T2	9100-0821		TRANSFORMER,PULSE (SEE A9T3)	28480	9100-0821
A9T3	9100-0820		TRANSFORMER,PULSE	28480	9100-0820
A9T4	9100-0820		TRANSFORMER,PULSE	28480	9100-0820
A10	04271-77212		BUFFER&CB AMPLIFIER ASSY	28480	04271-77212
A10	04271-61212		PC BOARD BLANK	28480	04271-61212
A10C1	0160-1554	1	CAPACITOR-FXD MY 0.33 UF 5% 200VDCM	28480	0160-1554
A10C2*	0150-0021	2	CAPACITOR-FXD .47PF +-5% 500VDC TI DIOX	28480	0150-0021
A10C3	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C4	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C5	0121-0048	1	CAPACITOR-V TRMR-CER 9-35PF 200V PC-MTG	52763	30A32Z 9/35PF N850
A10C6	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C7	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C10	0150-0034	1	CAPACITOR-FXD 3.9PF +-10% 500VDC TI DIOX	28480	0150-0034
A10C12	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C13	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C14	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A10C15	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C16	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C17	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C19	0140-0199		CAPACITOR-FXD 240PF +-5% 300VDC MICA	72136	DM15FA241J0300WV1CR
A10C20	0140-0193	1	CAPACITOR-FXD ---PF +-5% 300VDC MICA	72136	DM15E820J0300WV1CR
A10C21	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A10C22	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A10C23	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C24	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C25	0150-0121		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A10C26	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A10C27	0121-0043		CAPACITOR-V TRMR-PSTN .8-4.5PF		
A10C28	0140-1436	1	CAPACITOR-FXD MICA 98 PF +-1%	28480	0140-1436
A10C29	0121-0043		CAPACITOR-V TRMR-PSTN .8-4.5PF		
A10C30	0140-2205	1	CAPACITOR-FXD 120PF +-5% 300VDC MICA	28480	0140-2205
A10C31	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A10C32	0140-2204		CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0140-2204
A10C33	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A10C34	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A10C35	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A10C36	0160-0127		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A10C37*	0150-0021		CAPACITOR-FXD .47PF +-5% 500VDC TI DIOX	28480	0150-0021
A10C38*	0140-2246		CAPACITOR-FXD 3.9PF +-.25PF 500VDC CER	28480	0140-2246
A10C39*					
A10CR1	1902-0044		DIODE-ZNR 7.5V 5% DO-7 PD=.4W TC=+.05%	28480	1902-0044
A10CR2	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A10CR3	1902-0044		DIODE-ZNR 7.5V 5% DO-7 PD=.4W TC=+.05%	28480	1902-0044
A10CR4	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A10CR5	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A24	04271-77230	1	C/P/O BCD OUTPUT ASSY (OPT. 003)	28480	04271-77230
A24	04271-87230	1	PC BOARD BLANK	28480	04271-87230
A24C1	0180-1735		CAPACITOR-FXD 22UF+-10% 35VDC TA	56289	150D226X9035A2
A24C2	0160-1271		CAPACITOR-FXD 0.01 UF 5% 50VDC M	28480	0160-1271
A24C3	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A24C4	0160-0105		CAPACITOR-FXD 130PF +-5% 300VDC MICA	72136	DM15F131J0300WVICR
A24Q1	1854-0064		TRANSISTOR NPN SI		
A24Q2	1854-0064		TRANSISTOR NPN SI		
A24R1	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A24R2	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A24R3	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A24R4	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+800	01121	CB4715
A24R5	0683-2735		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A24R6	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A24U1	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A24U2	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A24U3	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A24U4	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A24U5	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A24U6	1820-0071		IC GPR TTL NAND DUAL 4-INP	01295	SN7440N
A24U7	1820-0176		IC INV TTL HEX 1-INP	01295	SN7404N
A24U8	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A24U9	1820-0328	4	IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
A24U10	1820-0072		IC GATE TTL AND-OR-INV DUAL 2-INP	01295	SN7450N
A24U11	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A24U12	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A24U13	1820-0328		IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
A24U14	1820-0072		IC GATE TTL AND-OR-INV DUAL 2-INP	01295	SN7450N
A25	04271-77231	1	PRMTR BCD OUTPUT CONT ASSY (OPT.004)	28480	04271-77231
A25	04271-87231	1	PC BOARD BLANK	28480	04371-87231
A25C1	0160-1271		CAPACITOR-FXD 0.01 UF 5% 50VDC M	28480	0160-1271
A25C2	0180-0218		CAPACITOR-FXD 15UF+-10% 35VDC TA	56289	150D156X9035A2
A25C3	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A25C4	0160-2207	1	CAPACITOR-FXD 300PF +-5% 300VDC MICA	28480	0160-2207
A25C5	0160-1545		CAPACITOR-FXD 0.022 UF 5% 50VDC M	28480	0160-1545
A25C6	0160-0105		CAPACITOR-FXD 130PF +-5% 300VDC MICA	72136	DM15F131J0300WVICR
A25C7	0180-1743		CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A25CR1	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A25CR2	1910-0016		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A25Q1	1854-0064		TRANSISTOR NPN SI		
A25Q2	1854-0064		TRANSISTOR NPN SI		
A25R1	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A25R2	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A25R3	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A25R4	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A25R5	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A25R6	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+800	01121	CB1025
A25R7	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A25R8	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A25R9	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A25R10	0683-2735		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A25R11	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A25R12	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+800	01121	CB2715
A25R13	0683-3315		RESISTOR 330 5% .25W FC TC=-400/+800	01121	CB3315
A25S1	3101-1313	1	SWITCH-SL DPST-NS MINTR .5A 125VAC/DC PC	28480	3101-1313
A25U1	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A25U2	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A25U3	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A25U4	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A25U5	1820-0301		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A25U6	1820-0071		IC GPR TTL NAND DUAL 4-INP	01295	SN7440N
A25U7	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A25U8	1820-0176		IC INV TTL HEX 1-INP	01295	SN7404N
A25U9	1820-0077		IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
A25U10	1820-0328		IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
A25U11	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A25U12	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A25U13	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A25U14	1820-0054		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N

See introduction to this section for ordering information

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION.

7-2. This section contains information for adapting this manual to instruments to which the contents do not directly apply. The following paragraphs explain how to adapt this manual to apply to older instruments with lower serial prefixes.

7-3. MANUAL CHANGES.

7-4. To adapt this manual to your particular instrument, refer to Table 7-1 and make all of the manual changes listed opposite your instrument serial number. Perform these changes in the sequence listed. Table 7-2 gives a manual changes summary by assembly.

7-5. If your instrument serial number is not listed on the title page of this manual or in Table 7-1 to the right, it may be documented in a yellow MANUAL CHANGES supplement. For additional information about serial number coverage, refer to INSTRUMENT IDENTIFICATION in Section I.

Table 7-1. Manual Changes by Serial Number.

Serial Prefix or Number	Make Manual Changes
1706J00110 and below	A, B, C, D, E, F, G, H, I
1706J00125 and below	B, C, D, E, F, G, H, I
1706J00145 and below	C, D, E, F, G, H, I
1706J00175 and below	D, E, F, G, H, I
1706J00205 and below	E, F, G, H, I
1706J00235 and below	F, G, H, I
1706J00415 and below	G, H, I
1833J00440 and below	H, I
1838J00741 and below	I

Table 7-2. Summary of Changes by Component.

Assembly	CHANGE								
	A	B	C	D	E	F	G	H	I
A1								X21L X26L X31L	
A2									
A3	R27, R28								C11
A4									
A5									
A6									
A7									
A8									
A9									
A10									

SECTION VIII
SERVICE

8-1. INTRODUCTION.

8-2. This manual section provides the information and instructions required for servicing the HP Model 4271B 1MHz Digital LCR Meter. Included are Theory of Operation and Troubleshooting Guide with Circuit Schematics. The Theory of Operation describes fundamental principles and circuit operating theory of the 4271B with block diagrams. Circuit schematics, locator illusrations, troubleshooting guide, and other technical data necessary for repairs are integrated into the service sheet foldouts. An illustration of the instrument interior is shown in Figure 8-35.

Note

When the instrument circuitry includes expanded capabilities provided by optional equipment, refer to paragraphs entitled OPTIONS for specific option service information.

WARNING

TROUBLESHOOTING AND REPAIR ARE ALLOWED FOR QUALIFIED TECHNICAL PERSONNEL ONLY. IF YOUR INSTRUMENT FAILS, REFER INSTRUMENT TO SERVICE PERSONNEL. H-P SERVICE OFFICES OFFER YOU THE BEST ANSWER TO YOUR PROBLEM. A GUIDE TO YOUR LOCAL H-P SERVICE OFFICES MAY BE FOUND ON THE BACK COVER OF THIS MANUAL.

8-3. THEORY OF OPERATION.

8-4. This theory of operation has been organized into three sections: basic theory, a block diagram discussion, and circuit analysis. The basic theory, beginning with paragraph 8-11, explains the concepts and fundamental theory of the 4271B instrument technique adapted for accurately measuring the DUT and for fully achieving automated measurement performance. The block diagram discussion describes the overall circuit operating theory of the 4271B with block-to-block signal flow. Included are block and timing diagrams. The circuit analysis provides a detailed description of how the circuit on each board functions. For reference convenience, when servicing the instrument, a circuit description is included in the service sheets.

8-5. TROUBLESHOOTING.

8-6. This troubleshooting guide provides instructions and information for locating a faulty circuit instrument component that requires service. All instructions consider the safety of service personnel who will perform the procedures. These diagnostic guides are in the form of step-by-step procedures with flow diagrams. The board level troubleshooting diagrams are the procedures for isolating the problem to an individual malfunctioning circuit board assembly. The guides for locating a defective component are given on the individual board service sheets and integrate service support data — test point locations, waveform illusrations, voltage data, timing diagrams, and other technical information in addition to providing schematic diagrams for each board.

8-7. RECOMMENDED TEST EQUIPMENT.

8-8. The test equipment required to perform operations outlined in this section is listed in Table 4-1. The table includes: type of instrument required, critical specifications, use, and recommended model. If the recommended model is not available, equipment which meets or exceeds critical specifications listed may be substituted.

8-9. REPAIR.

8-10. Repair explanations tell how to replace defective circuit components. The recommended replacement procedures for components and parts which require special repair, replacement tools, or test equipment should be observed. Correct disassembly and the exchange procedures for such special parts are outlined in Paragramphs 8-71 through 8-75. To prevent damage from inproper repair procedure, refer to the appropriate manual section before proceeding with repair.

Table 7-2. Summary of Changes by Assembly (Continued).

Assembly	CHANGE								
	A	B	C	D	E	F	G	H	I
A11									
A12							C8, C13		
A13									
A14									
A15									
A16									
A17									
A18									
A19									
A20									
A21									
A23									
A24									
A25									
A26									
A31	C7			C7, 8, CR4, R2, 12					
A32									
A33									
A34						J1, 2			
A35				CR5, F1, 2					
No Prefix	DECK-R	F1, 2	CR5		HP-IB CABLE			PC BD EXTENDER	

8-11. BASIC THEORY.

8-12. The HP Model 4271B is comprised of three major circuit sections (see Figure 8-1). The Bridge Section, here a voltage ($V_{variable}$) proportional to value of DUT (device under test) and a voltage (V_{ref}) proportional to the Range Resistance are developed and transmitted to the measurement section. In the measurement section, the value of the DUT is measured as a ratio of $V_{variable}$ to V_{ref}. This value is presented to and displayed by the Digital Control and Display Section. The Digital Control and Display Section controls the Bridge and Measurement Sections.

8-13. Bridge Section.

3-14. A simplified diagram of the Bridge Section is shown in Figure 8-2. Figure 8-2 is the simplified circuit for a C-G (C-D) measurements.

8-15. In making C-G (C-D) measurements, the constant voltage V_{ref} is applied to the DUT and V_{var} to range resistor G_R. The V_{var} is a variable voltage and is proportional to the values of C_X and G_X when the unbalance current i_d becomes zero (bridge is balanced). Derivation of V_{var} is given by the following equation:

$$V_{var} = -V_{ref} \cdot \left(\frac{G_X}{G_R} + j \frac{\omega C_X}{G_R} \right) \qquad (8\text{-}1)$$

V_d has to be accurately zero for V_{ref} and V_{var} to be accurate. To do this a bridge technique is used in the 4271B.

8-16. For L-R (L-D) measurements, V_{ref} is applied to range resistor and V_{var} to H_{CUR} terminal on front panel. Thus, the current flowing through DUT is determined by the values of V_{ref} and the range resistor and, therefore, becomes a constant current. As the voltage V_{var} across the DUT is the product of the above constant current and the impedance of DUT, V_{var} is proportional to the value of DUT:

$$V_{var} = -V_{ref} \cdot \left(\frac{R_X}{R_R} + j \frac{\omega L_X}{R_R} \right) \qquad (8\text{-}2)$$

$(R_X + j\omega L_X)$ is a sample.

Equations (8-1) and (8-2) are of the same type. This shows that the measurement method is same for C-G and L-R measurements. As the bridge circuit in the 4271B uses the four-terminal pair method, lead wires can be extended to the measuring point. The measuring error can thus be minimized.

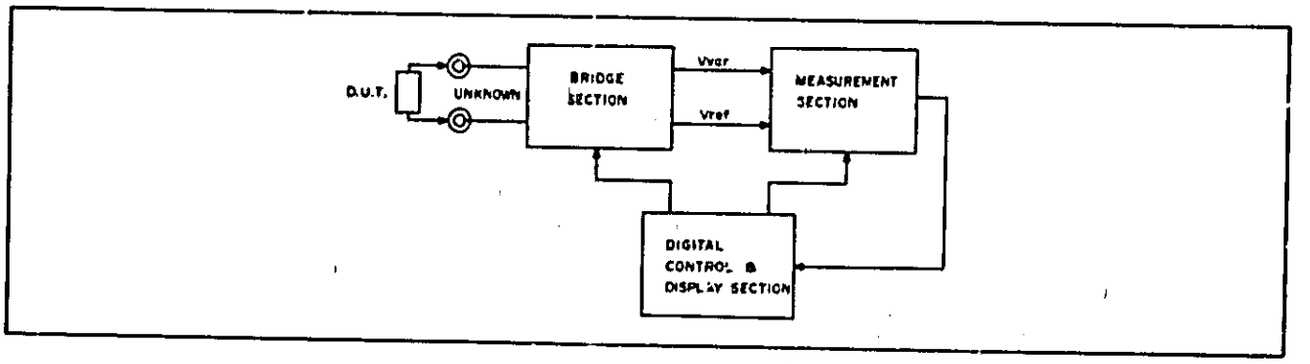


Figure 8-1. Block Diagram of 4271B Principles.

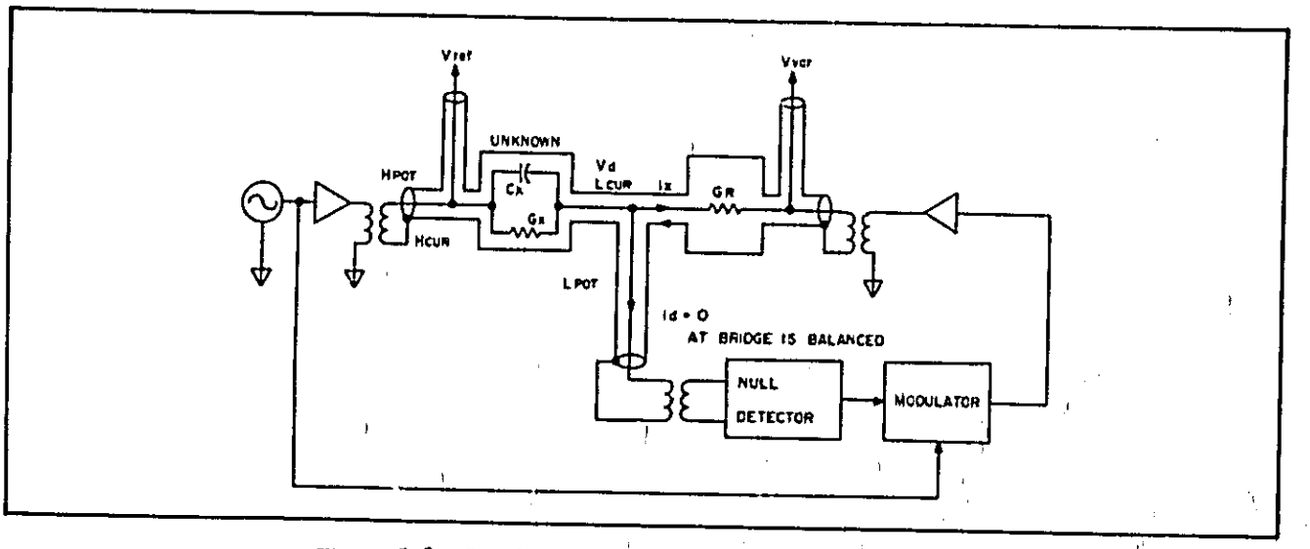


Figure 8-2. Simplified Block Diagram of Bridge Section.

CHANGE A

Page 6-4, Table 6-3, Replaceable Parts,
Delete following parts:

A3R27; HP P/N: 0757-0439, R-FXD 681K 1%
A3R28; HP P/N: 0757-0438, R-FXD 5.11K 1%

Add following parts:

A3R27; HP P/N: 0698-2188, R-F 7K 0.25%
A3R28; HP P/N: 0698-2189, R-F 5K 0.25%

Page 6-28, Table 6-3, Replaceable Parts,
Add following part:

A31C7; HP P/N: 0150-0121, C-FXD 0.1μF

Page 6-30, Table 6-3, Replaceable Parts,
Delete following part:

HP P/N: 04271-00101, DECK-R

Add following part:

HP P/N: 04271-10041, DECK-R

CHANGE B

Page 6-30, Table 6-3, Replaceable Parts,
Delete following parts:

F1; HP P/N: 2110-0305, FUSE 1.25A 250V
F2; HP P/N: 2110-0339, FUSE 0.60A 250V

Add following parts:

F1; HP P/N: 2110-0007, FUSE 1A 250V.
F2; HP P/N: 2110-0202, FUSE 0.5A 250V

CHANGE C

Page 6-30, Table 6-3, Replaceable Parts,
Add following part:

CR5; HP P/N: 1884-0005, THYRISTOR-SCR

CHANGE D

Page 6-28, Table 6-3, Replaceable Parts,
Delete following parts:

A31C7; HP P/N: 0180-0228, C-FXD 22μF 15VTA
A31C8; HP P/N: 0180-0228, C-FXD 22μF 15VTA
A31CR4; HP P/N: 1902-1158, DIODE-ZENER 9.76V ±2%
A31R2; HP P/N: 0683-4715, R-FXD 470Ω 5%
A31R12; HP P/N: 0757-0438, R-FXD 5.11K 1%

Add following parts:

A31CR4; HP P/N: 1902-3160, DIODE-ZENER 10.0V ±2%
A31R2; HP P/N: 0683-2225, R-FXD 2.2K 5%

8-17. Measurement Section.

8-18. The Measurement Section employs the dual slope type DVM measuring technique. Figure 8-3 is a simplified block diagram of the measurement section. The C-G measurement equation is then:

$$V_{var} = -V_{ref} \cdot \left(\frac{G_X}{G_R} + j \frac{\omega C_X}{G_R} \right) \quad (8\text{-}3)$$

[See (9-1)]

Switches S_V, S_G, S_{X_1} and S_{X_2} are closed and two integrators are charged for the constant time T_1 (20ms). The charges $q_{C/L}$ and $q_{G/R}$ in their respective integrators are:

$$q_{C/L} = -k_1 \frac{\omega C_X}{G_R} G_S V_{ref} T_1 \quad (8\text{-}4)$$

$$q_{G/R} = -k_2 \frac{G_X}{G_R} G_S V_{ref} T_1 \quad (8\text{-}5)$$

After charging for T_1, switches S_r, S_c(SG), S_{X_1} and S_{X_2} are closed and $q_{C/L}$ and $q_{G/R}$ are discharged until the outputs of the integrators become 0 volts. When the discharge time of the C/L integrator is T_2:

$$-K_1 \frac{\omega C_X}{G_R} V_{ref} G_S T_1 + K_1 V_{ref} \omega C_S T_2 = 0 \quad (8\text{-}6)$$

$$\frac{T_2}{T_1} = \frac{G_S}{G_R} \cdot \frac{1}{C_S} C_X \quad (8\text{-}7)$$

Thus, the value of C_X is known by counting and displaying time T_2. When the discharge time of G/R integrator is T_3:

$$-K_2 \cdot \frac{G_X}{G_R} \cdot V_{ref} \cdot G_S T_1 + K_2 V_{ref} \cdot G_S \cdot T_3 = 0 \quad (8\text{-}8)$$

$$\frac{T_3}{T_1} = \frac{1}{G_R} \cdot G_X \quad (8\text{-}9)$$

G_X becomes known by counting and displaying time T_3. The coefficients K_1 and K_2 do not cause a measurement error. Applying equation (8-2) instead of (8-1) to the above enables L_X and R_X measurements to be made instead of those for C_X and G_X. To avoid an error caused by interference between simultaneous (C-G) and (L-R) measurements, each measurement should be performed independently.

8-19. D-Measurements.

8-20. Switches S_r, S_c, and S_{X_1} are closed and the C/L integrator is charged during time T_4. After charging, switches S_V, S_G, S_{X_1} and S_{X_2} are closed and the charge of the C/L integrator is discharged until the output of C/L integrator becomes 0 volts. During discharge time T_5, G/R integrator is simultaneously charged. Therefore:

$$V_{ref} \cdot \omega C_S \cdot T_4 - V_{ref} \cdot \frac{\omega C_X}{G_R} \cdot G_S \cdot T_5 = 0 \quad (8\text{-}10)$$

Switches S_r, S_G and S_{X_2} now close and the charge of G/R integrator is discharged until the output of G/R integrator becomes zero volts. This discharge time is T_6, and:

$$-V_{ref} \frac{G_X}{G_R} \cdot G_S T_5 + V_{ref} G_S T_6 = 0 \quad (8\text{-}11)$$

From the above two equations:

$$\frac{T_6}{T_4} = \frac{C_S}{G_S} \cdot \frac{G_X}{C_X} = \frac{\omega C_S}{G_S} \cdot \frac{G_X}{\omega C_X} = \frac{D_X}{D_S} \quad (8\text{-}12)$$

When C_S = 100pF, G_S= 1mS and $\omega = 2\pi \cdot 10^6$ rad., from the above equation:

$$D_S = \frac{G_S}{\omega C_S} = \frac{10^{-3}}{2\pi \cdot 10^6 \cdot 100 \cdot 10^{-12}} = 1.5920 \quad (8\text{-}13)$$

To directly display the value of D_X from the time T_6, T_4 is set to the time corresponding to 15920 clock pulses.

8-21. Digital Control/Display Section.

8-22. The Digital Section counts and displays time interval from Measurement Section and executes timing control, range control, etc. of the Bridge and Measurement sections.

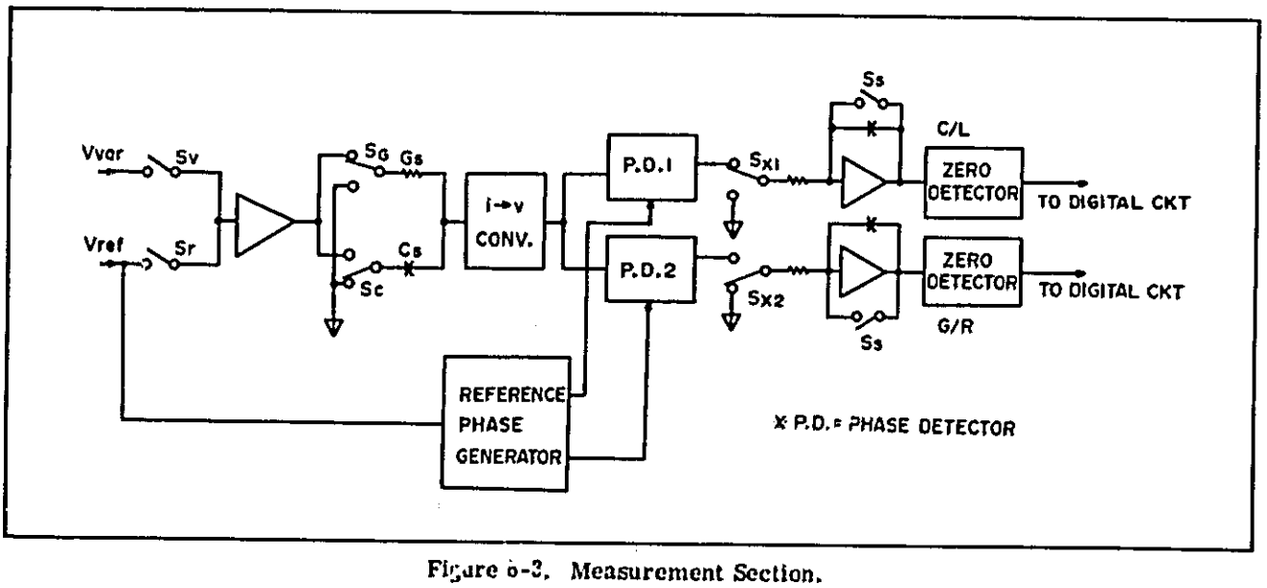


Figure 8-3. Measurement Section.

Page 6-30, Table 6-3, Replaceable Parts,
Delete following parts:

F1; HP P/N: 2110-0007, FUSE 1A 250V
F2; HP P/N: 2110-0202, FUSE 0.5A 250V

Add following parts:

F1; HP P/N: 2110-0305, FUSE 1.25A 250V
F2; HP P/N: 2110-0339, FUSE 0.60A 250V

CHANGE E

Page 6-3[illegible], Table 6-3, Replaceable Parts,
Add following part:

HP P/N: 04271-61602, HP-IB CABLE-ASSY

CHANGE F

Page 6-29, Table 6-3, Replaceable Parts,
Delete following parts:

A34J1; HP P/N: 1200-0482, SOCKET-IC
A34J2; HP P/N: 1200-0482, SOCKET-IC

Add following parts:

A34J1; HP P/N: 1200-0436, SOCKET-IC
A34J2; HP P/N: 1200-0436, SOCKET-IC

CHANGE G

Page 6-17, Table 6-3, Replaceable Parts,
Delete following parts:

A12C8; HP P/N: 0121-0105, CAPACITOR-V TRMR-CER 9-35pF 350V
A12C13; HP P/N: 0121-0036, CAPACITOR-V TRMR-CER 5.5-18pF 350V

Add following parts:

A12C8; HP P/N: 0121-0036, CAPACITOR-V TRMR-CER 5.5-18pF 350V
A12C13; HP P/N: 0121-0059, CAPACITOR-V TRMR-CER 2-8pF 350V PC-MTG

CHANGE H

Page 6-3, Table 6-3, Replaceable Parts,
Delete following parts:

A1X21L; HP P/N: 1251-2035, CONNECTOR-PC
A1X25L; HP P/N: 1251-2035, CONNECTOR-PC
A1X31L; HP P/N: 1251-2035, CONNECTOR-PC

Add following parts:

A1X21L; HP P/N: 04271-30030, CONNECTOR-PC
A1X25L; HP P/N: 04271-30030, CONNECTOR-PC
A1X31L; HP P/N: 04271-30030, CONNECTOR-PC

Page 6-31, Table 6-3, Replaceable Parts,
Add following parts:

HP P/N: 04271-77221, EXTENDER BOARD ASSY
HP P/N: 04271-77223, EXTENDER BOARD ONLY FOR A19 BD

8-23. BLOCK DIAGRAM DISCUSSION.

8-24. Figure 8-4 is a simplified block diagram of the Model 4271B. This diagram is composed of blocks representing board assemblies.

8-25. Analog Section.

8-26. Figure 8-5 is a detailed block diagram of analog section. Outputs of A4 Oscillator are sent to A9 Power Amplifier, A8 Modulator and A13 Reset/Clock Pulse Generator. HPOT terminal on front panel of 4271B is connected to A11 Current Detector. A11 Current Detector detects and amplifies unbalance current of bridge which is the difference of current flow between DUT and range resistor of A12. The output of A11 Null Detector is sent to A8 Modulator as an unbalance voltage signal. A8 Modulator controls the amplitude and phase of a modulated voltage to drive the unbalance voltage to be zero volts. This modulated voltage and the constant voltage from A4 Oscillator are applied through switches to the power amplifiers of A9, respectively. One output of A9 Power Amplifier is fed to HCUR terminal and the other to the range resistor of A12. Range resistors of A12 are switched by the range control signal from A16 Function/Range Control. V_D which is the voltage of HPOT terminal and V_R which is the voltage across the range resistor are sent to A10 Buffer Amplifier/Gs, Cs CKT. V_D and V_R are applied to A6, 7 Phase Detector/Integrator through switches, Cs/Gs circuit and amplifier which are controlled by the signal from A15 Step Control. A6 and A7 convert measured quantity to time interval by the dual slope technique and the time interval signal is sent to A14 Gate/Transfer Control. The reference phase signals required in the phase detectors of A6 and A7 are generated by A5 Reference Phase Generator.

8-27. Digital Section.

8-28. Figure 8-6 is a detailed block diagram of Digital Section. Board A13 is the Reset/Clock Pulse Generator. It produces 500kHz clock pulses generated by a 1MHz sine wave and operates whenever the power switch is on. During the sampling time reset pulses are generated. In A14 Gate/Transfer Pulse Control the counter reset signal and gate signal are transmitted to A18 Counter. A 400μsec time span is generated. A switch control signal is generated and transmitted to A6, A7 Integrators. A step shift signal is transmitted to A15 and with the step signal from A15, the transfer pulses are transmitted to A18 Counter and A19 Display. In A15 Step Control, the step counter is advanced by the step shift signal from A14. The step signals generated by the step counter control switches of A10 Buffer Ampl. & Cs, Gs Ampl. A15 receives integrator zero detect signal from A6/A7 or overflow signal from A18 and transfers "0" detect signal to A14. In A16 Function and Range Control, range and function signals are generated by range and function signals from A2 Front Panel (or Remote) and transmitted to A17 Auto Range and Lamp Driver. The range switch signal is transmitted to A12 Reference Resistor. A17 Auto Range/Lamp Driver, lights the unit lamps of A19 Display by decoding function and range signals from A16. The control signal for auto ranging is generated by signals from A13, A15 and A18 and transferred to A13 and A16. In A18 Counter, by the enabling gate signal from A14, clock pulses are counted in the decimal system. Meaningless digits are blanked depending upon position of Range and Function control settings. The overflow signal is transmitted to A15, A16 from the A18 counter. Also produced is the 10000 count detect signal and the 15920 count detect signal which are transmitted to A14 to control change time of integrator. In A19 Display, LED-ICs are used. Each of the ICs includes a BCD to decimal decoder and a latch memory.

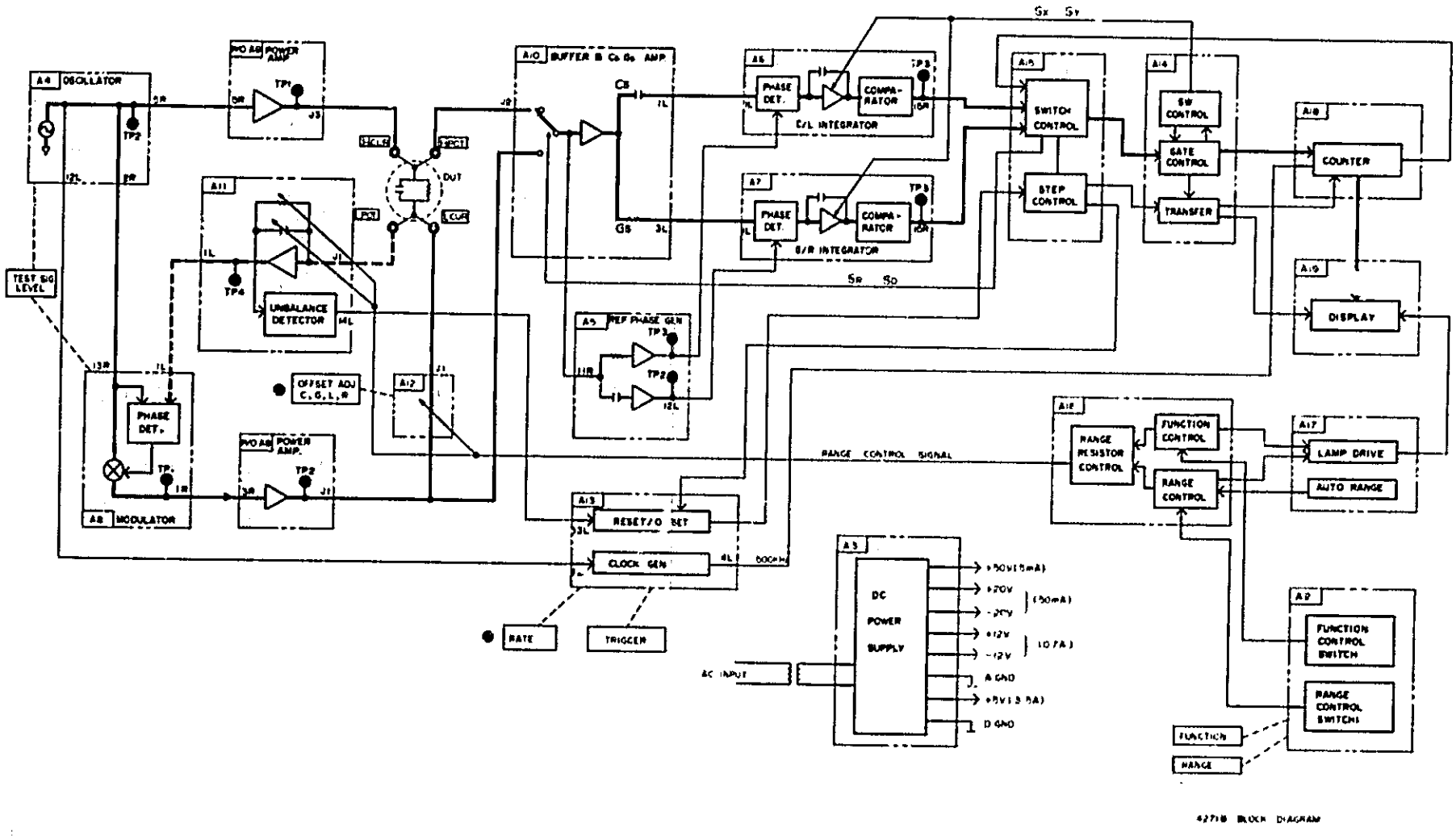
CHANGE I

Page 6-4, Table 6-3, Replaceable Parts List,

Page 8-43, Figure 8-41, Component Locations,

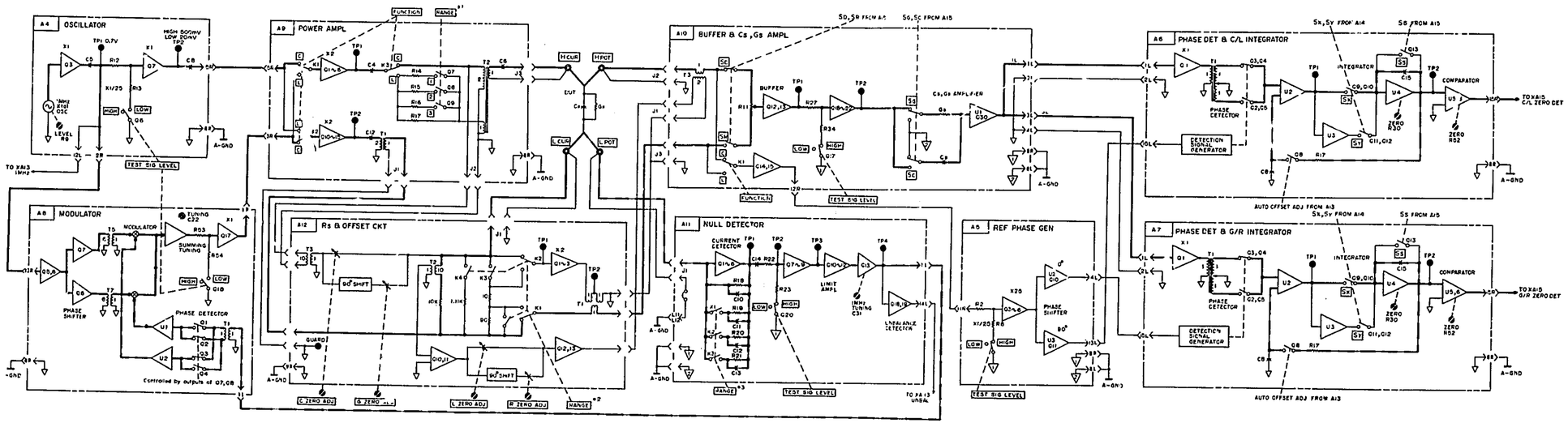
Page 8-43, Figure 8-42, Schematic Diagram,
Delete following part:

A3C11; HP P/N: 0186-0076, C 22μF, 50V



4271B BLOCK DIAGRAM

Figure 8-4. Simplified Block Diagram.



*1: When L-RANGE is selected as shown in diagram, Q7, Q8 and Q9 are turned on, respectively.

*2: K_1, K_2 and K_3 turn on according to following RANGE and FUNCTION switch positions:

K_1	C, 4 L, 1
K_2	C, 3 L, 4 C, 2 L, 3
K_3	C, 3 L, 2 C, 4 L, 1
K_4	C, 2 L, 3
Q_1	C, 4 L, 1

*3: K_1, K_2 and K_3 turn on according to following RANGE and FUNCTION switch positions:

K_1	C, 2 L, 3
K_2	C, 3 L, 2
K_3	C, 4 L, 1

Figure 8-5. Detailed Block Diagram (Analog Section).

Figure 8-4
Simplified Block Diagram
SEE INSIDE

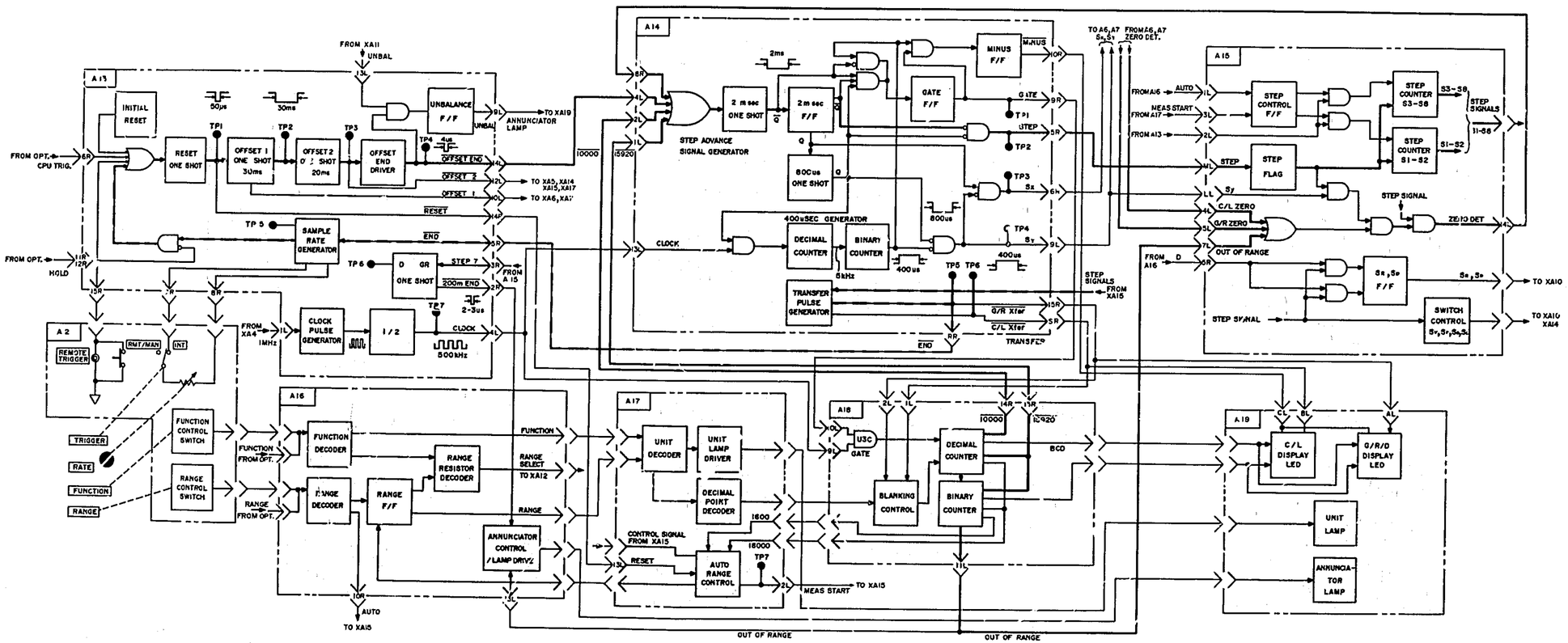


Figure 8-6. Detailed Block Diagram (Digital Section).

(2) Unit/Decimal Point Display Indications. Troubleshoot according to Figure 8-19.

(3) Annunciator Check.

(3-1) UNBAL lamp. Model 4271B Setup:

UNKNOWN ..... SHORT
FUNCTION ..... C-G

UNBAL lamp should turn on and off at rate of sample RATE. If not, check A13 (UNBAL F/F) and A19 (UNBAL lamp).

(3-2) OUT OF RANGE lamp.

UNKNOWN ..... OPEN
RANGE 1
FUNCTION ..... L-R

NOTE

Number and time relationship of pulses for one measurement cycle should be exactly as shown.

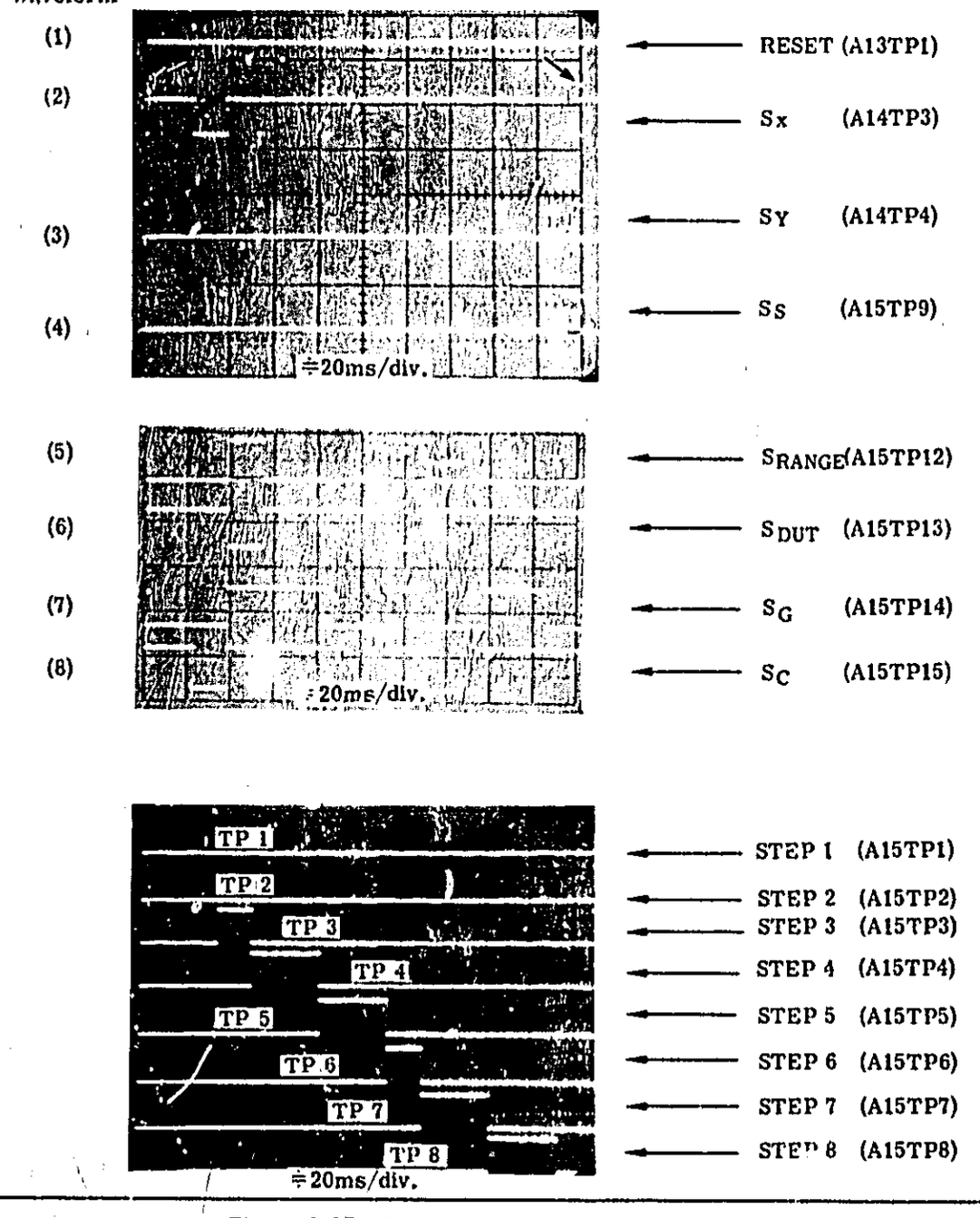
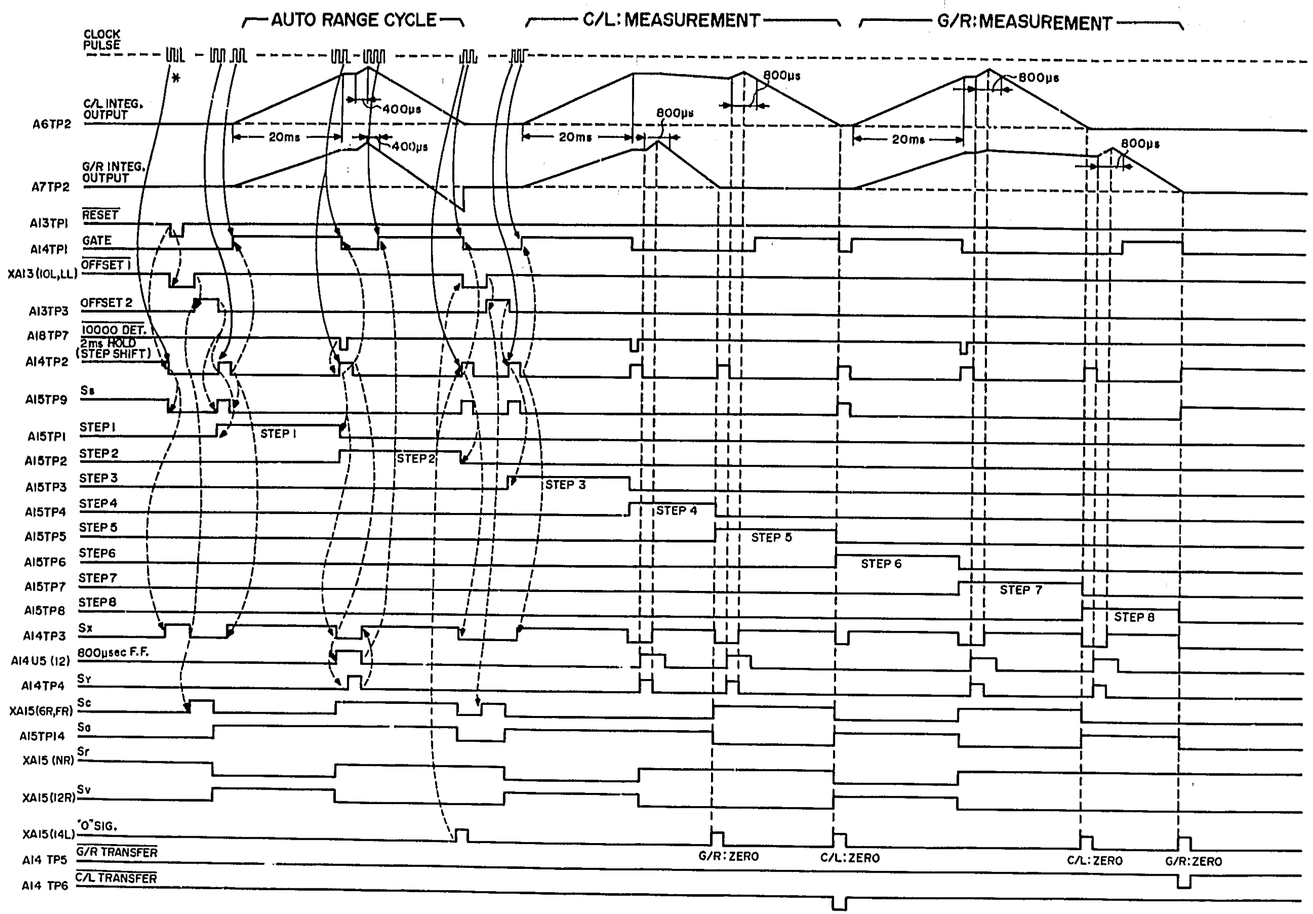


Figure 8-15. Waveforms for Analog/Digital Isolation.



* ARROWS FROM CLOCK PULSES MEAN TO SYNCHRONIZE WITH CLOCK PULSE

Figure 8-7. Timing Diagram.

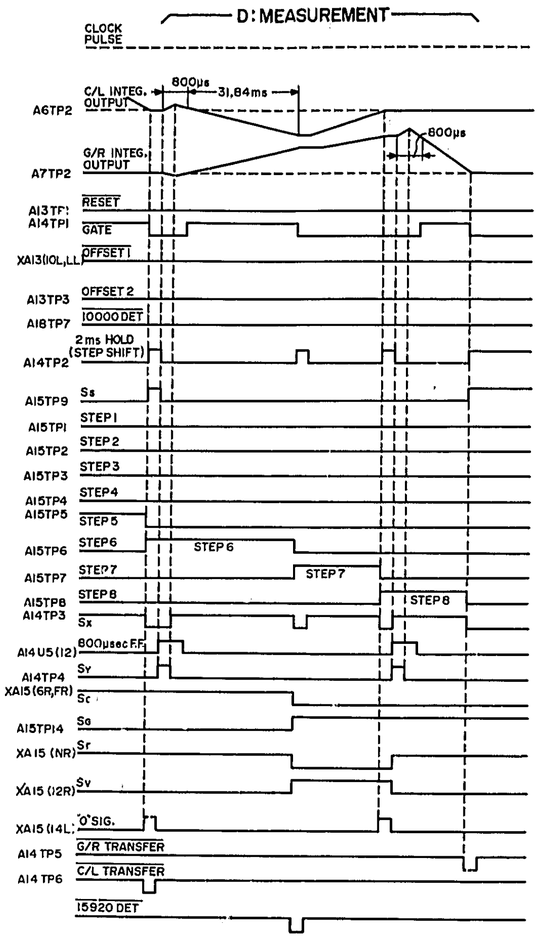


Figure 8-6
Detailed Block Diagram (Digital Section)

SEE INSIDE

Trigger oscilloscope externally with signal from A4TP1.

Check waveform at A5TP2 & TP3.

There is 90° phase shift between these two signals.

OK

Trigger oscilloscope externally with signal from A13TP1.

RANGE: 3
FUNCTION: C-G
DUT: 1000pF in parallel with 100Ω.

Check waveform at A6TP3.

OK

Check waveform at A7TP3.

OK

A10 is faulty.

NO

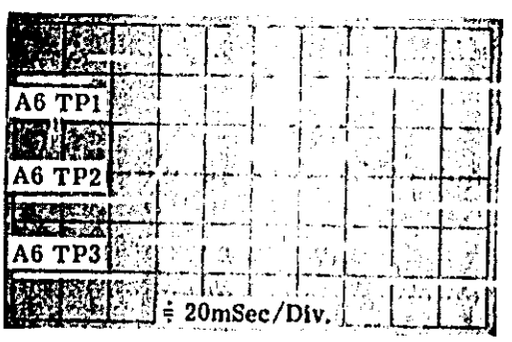
A7 is faulty.

NO

A6 is faulty.

NO

A5 is faulty.



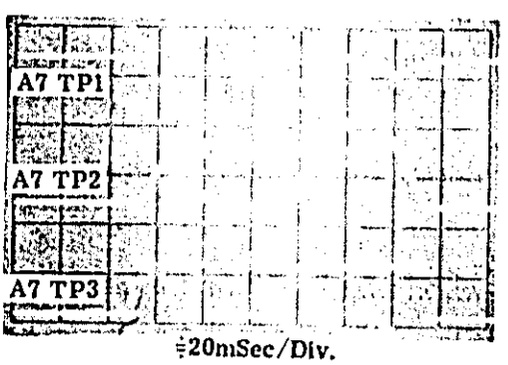


Figure 8-17. Measurement Section.

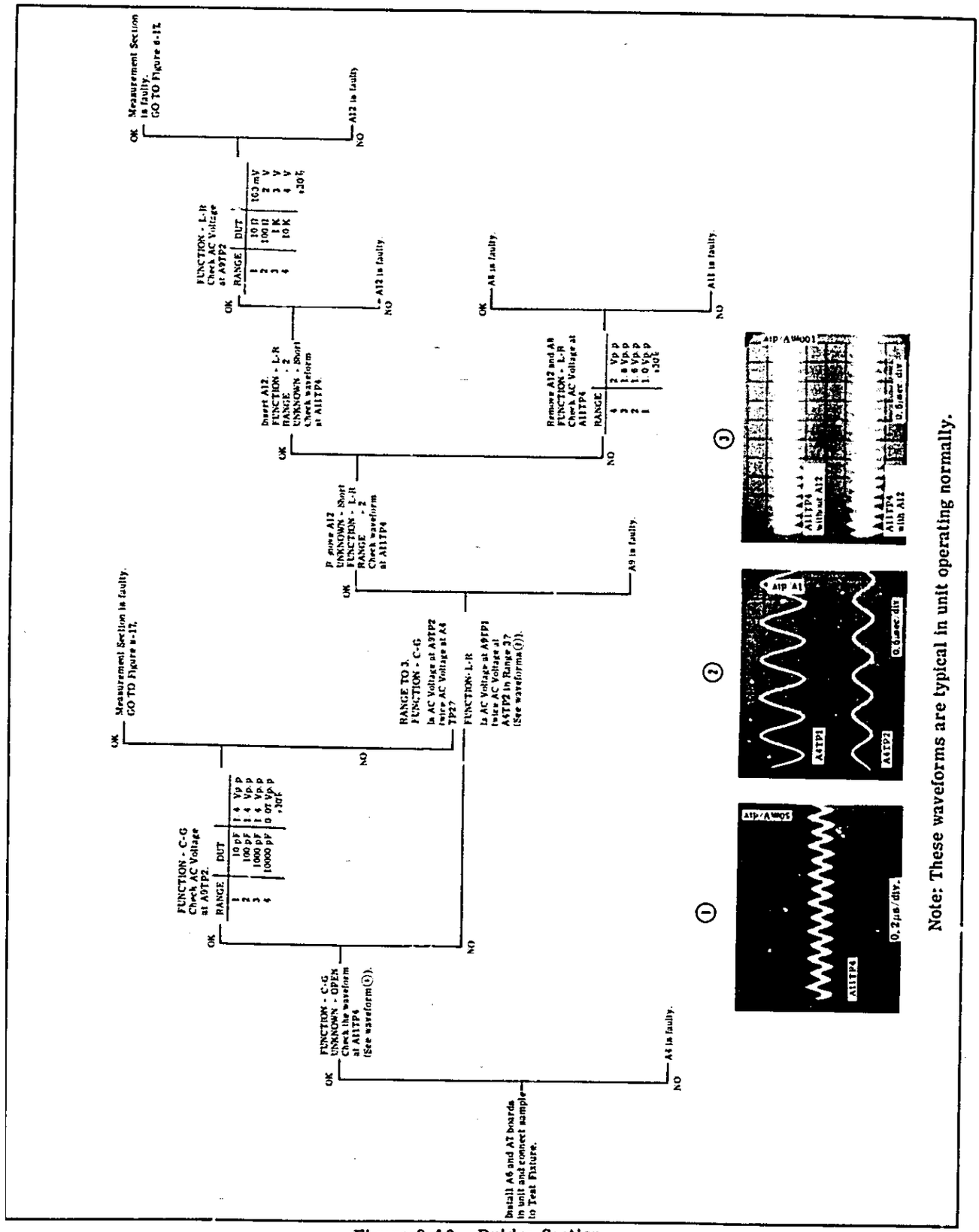


Figure 8-16. Bridge Section.

8-29. TIMING DIAGRAM DISCUSSION.

8-30. The dual slope type DVM which is used in the Model 4271B individually integrates the real parts (G/R) and imaginary parts (C/L) of the measured voltage. This interaction is performed alternately to avoid mutual interaction. When the AUTO range is selected, C/L and G/R are initially charged together and discharged to select the suitable range. C/L and G/R are again charged together, C/L is discharged and counted and then G/R is charged and discharged and counted. Before discharging, the integrator charges for 400μsec to measure small values correctly (see Figure 8-7).

8-31. For descriptive purpose refer to Figure 8-7. When the power switched to on, there is about 2sec hold time until the output of OSC becomes stable. After this hold time a reset pulse is generated by the reset one shot and all the logic circuits are reset. An offset 1 pulse (30msec) is generated with the reset pulse and during this time (30msec) the offset adjustment of A6, A7 is performed. After offset adjustment the offset 2 pulse (20msec) is generated. An offset end pulse (4μsec) is generated by the output of offset 2 pulse and with this pulse a 2msec hold signal is generated. During this time the outputs of the integrators are driven to zero. At this moment, step 1 begins. In step 1 S_G, S_V, S_X signals are turned on to integrate the unknown signal through G_S of A10. The charge time is set at 10000 counts (20msec). When the detect signal of 10000 counts is generated, a 2ms hold signal is generated and step 2 starts and S_X is turned off. During step 2, S_G, S_C, S_R, signals are turned on to discharge with reference signal. A 800 μsec time span after the 2msec hold time protects the zero detector from mis-operating because of switching transients. The gate of counter is opened after 800μsec time span. After gate is opened, the two integrators are discharged with reference signal and counting is performed until the output of the integrators become zero and a "0" detect signal is generated (at the end of the count). That is to say, the range is set by the larger of C/L or G/R. If the count in step 2 is between 1602 and 18040, a "start measure" signal is generated; if not, a "range shift" signal and an "up shift" or "down shift" signal are generated If a "start measure" signal is generated, the offset adjust by offset 1 is performed again and step 3 begins. If a "range shift" signal is generated, the offset 1, offset 2, and step 1 begin again (on another range). Beginning with step 3, an actual measurement is performed.

8-32. Steps 3 to 5 are the C/L measuring cycle. Step 3 is as same as step 1 (sometimes the range is different). In step 3, the unknown signal is charged up during 10000 counts. A 2msec hold is performed and then step 4 starts. After the 2msec Hold, the integrator is charged with the reference signal for 400 μsec through G_S of A10 (S_Y is on). The S_Y is turned off and S_X is turned on. The G/R Integrator is discharged with reference signal until output of the integrator becomes zero. During this discharging, a small portion of C/L, which originated when G/R was charged, flows away. This is the compensation cycle. After compensation cycle, a 2msec hold time is used again. After the hold time, S_Y is turned on, C/L integrator is charged through C_S of A10 with the reference signal for 400μsec. S_X is turned on and C/L Integrator is discharged with reference signal after S_X is turned on. The gate of counter is opened until output of C/L Integrator becomes zero and number of the counts is displayed with C/L transfer pulse.

8-33. Steps 6, 7, 8 are the G/R measuring cycle. This cycle is as same as the C/L measuring cycle except that C/L is exchanged for G/R.

8-34. D Measurement.

8-35. In D measurements the first to fifth steps are performed the same as for G or R measurements. After the 2msec hold time of sixth step, S_Y signal is at high level for 400μsec. The integrators are charged up through G_S of A10 board by reference signal After this 400μsec, S_Y signal becomes low level and S_X signal becomes high level and charging starts. As soon as it passes 400μsec (after S_X signal is at high level), the Gate is opened and continues to remain open for 15920 counts of counter. Immediately after the 15920 counts signal is detected, a 2msec hold signal is generated and seventh step starts. In seventh step, G/R integrator is integrated through G_S of A10 board by unknown signal until output of C/L integrator becomes 0 volt. As integrated value of G/R integrator has D information, the G/R integrator is discharged by reference signal in either step and its discharging time is counted and displayed. The display of the value of D is performed by G/R transfer pulse which is also used as an END pulse.

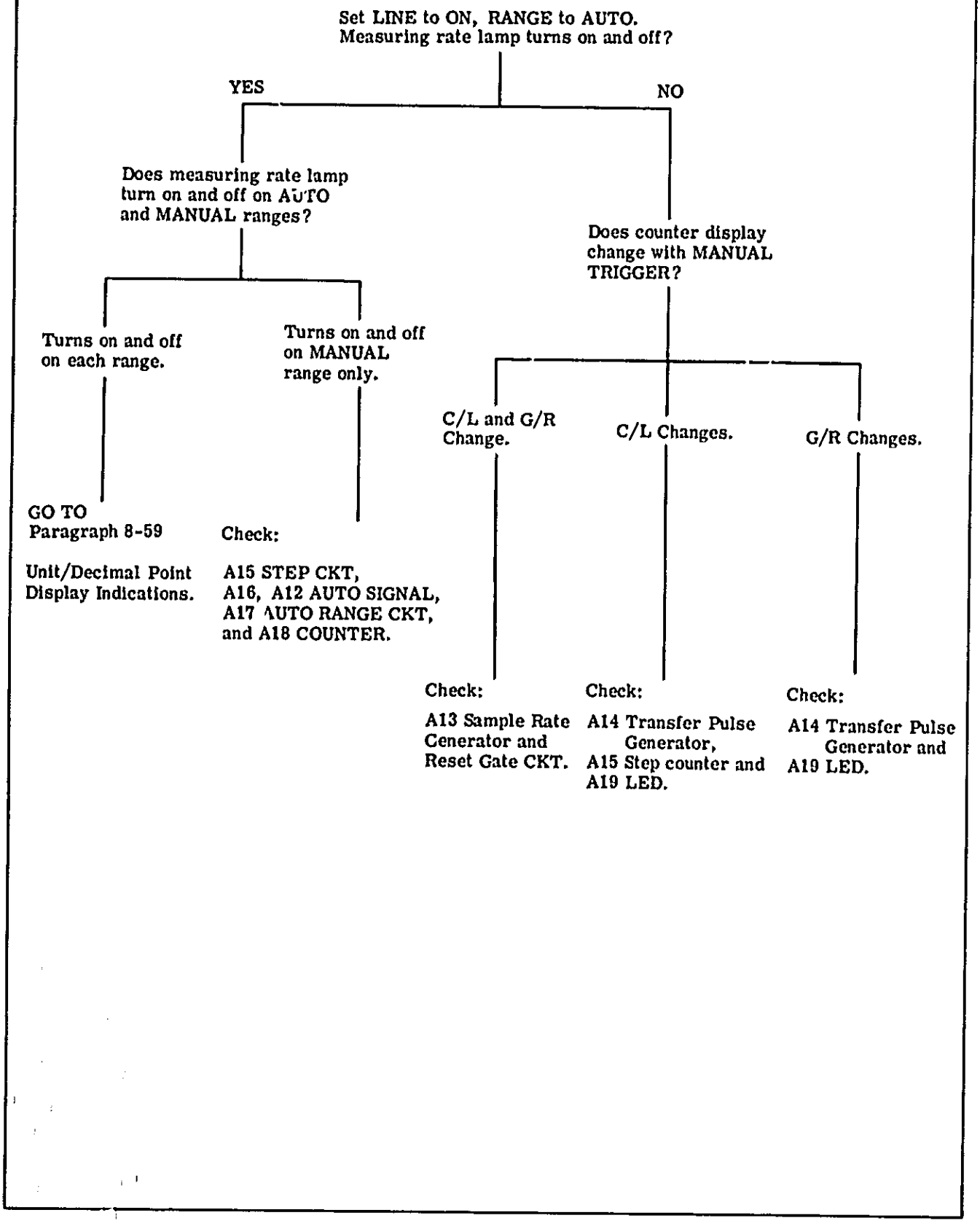


Figure 8-18. Trouble Diagnosis from Measuring Rate Lamp Indications.

8-36. OPTIONS.

8-37. Option 001.

8-38. The block diagram of OPT 001 (A21 Bias Voltage Supply) is shown in Figure 8-8. Bias voltage selection is accomplished by control signals from external bias voltage controller which turns transistors Q1 to Q40 on or off. Switching transistors connect or disconnect resistors in a weighed BCD code referred to the stable +5V reference voltage. This switching system delivers exact incremental output voltages from 0.0 to +39.9V DC synthesized from the +50VDC supply. As long as a reset pulse is not supplied to the circuit after a voltage setting, the bias voltage applied to sample does not change even if the setting bias voltage of the controller is varied. When the bias voltage is changed, switching voltage transients are not generated. Thus, the unknown device (or sample) can not be injured or destroyed by Opt. 001 Bias Control circuitry.

NOTE

This option supplies a bias voltage to the sample (not a bias current).

8-39. Option 002.

8-40. Refer to Figure 8-9. The interface board A23 C/L Parallel BCD Output (Option 002) conditions capacitance or inductance data from 4271B standard instrument for transfer to a digital recorder. Transferred data are stored in a latch memory by a $\overline{\text{CXfer}}$ pulse and printed by digital recorder which is instructed to print by a +PC (Print Command) pulse. The 4271B can not be triggered as long as the +INHIBIT signal is at high level after +INHIBIT signal is delivered from digital recorder to 4271B by leading edge of +PC pulse. Signals for Data Multiplier, Unit, Out of Range, Unbal, Minus and so on are also transferred from 4271B to digital recorder and printed accordingly. Refer to Section III for printing and timing formats.

8-41. Option 003.

8-42. Circuits of A24 Board (Option 003) are about the same as for A23 Board of Option 002 (q.v). Thus, an explanation for A24 is omitted.

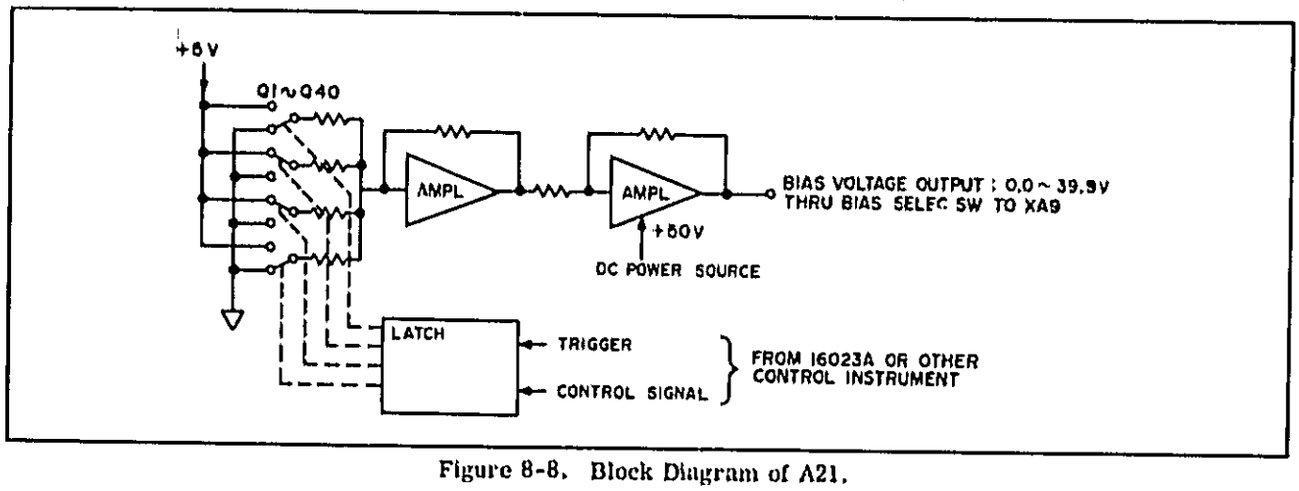


Figure 8-8. Block Diagram of A21.

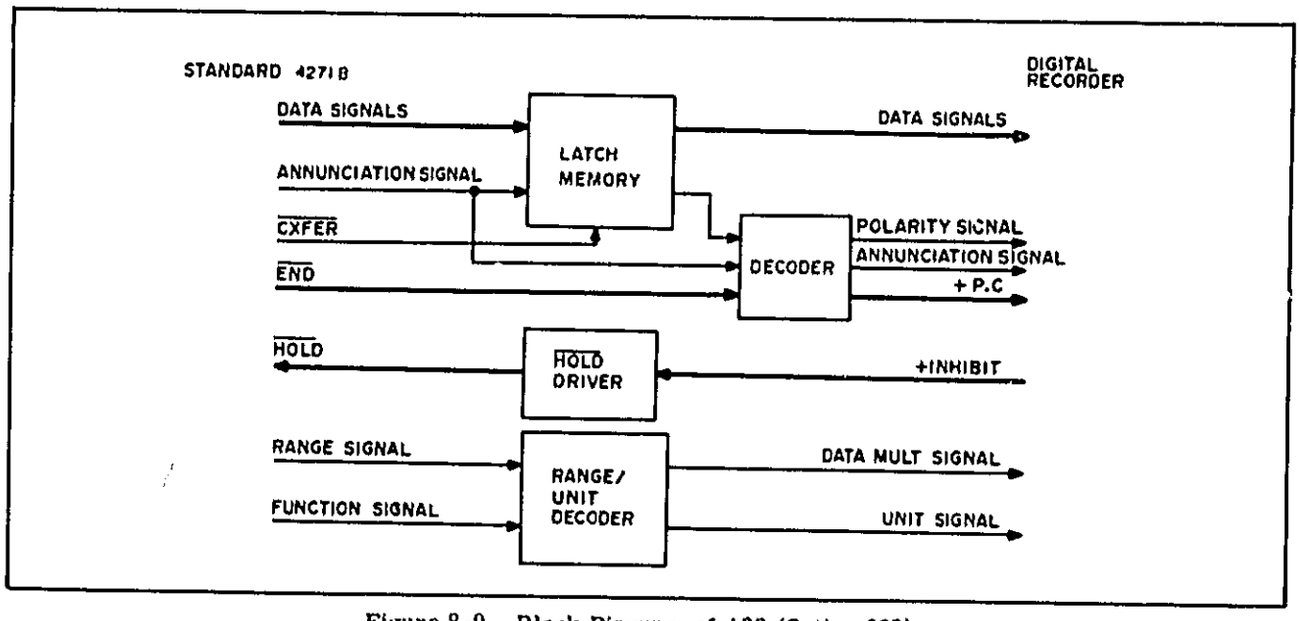
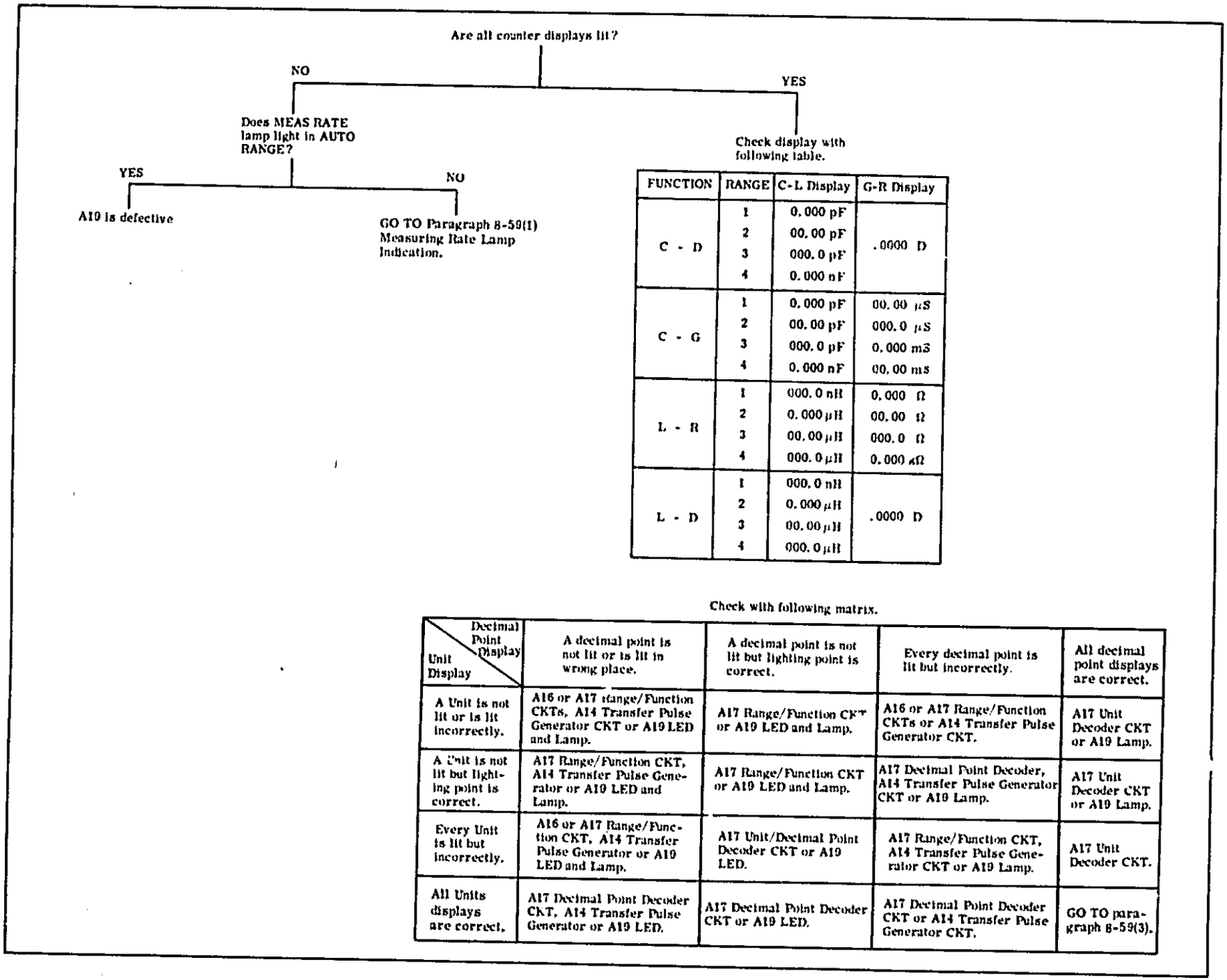


Figure 8-9. Block Diagram of A23 (Option 002).



FUNCTION	RANGE	C-L Display	G-R Display
C - D	1	0.000 pF	.0000 D
	2	00.00 pF	
	3	000.0 pF	
	4	0.000 nF	
C - G	1	0.000 pF	00.00 μS
	2	00.00 pF	000.0 μS
	3	000.0 pF	0.000 mS
	4	0.000 nF	00.00 mS
L - R	1	000.0 nH	0.000 Ω
	2	0.000 μH	00.00 Ω
	3	00.00 μH	000.0 Ω
	4	000.0 μH	0.000 kΩ
L - D	1	000.0 nH	.0000 D
	2	0.000 μH	
	3	00.00 μH	
	4	000.0 μH	

Check with following matrix.

Unit Display \ Decimal Point Display	A decimal point is not lit or is lit in wrong place.	A decimal point is not lit but lighting point is correct.	Every decimal point is lit but incorrectly.	All decimal point displays are correct.
A Unit is not lit or is lit incorrectly.	A16 or A17 Range/Function CKTs, A14 Transfer Pulse Generator CKT or A19 LED and Lamp.	A17 Range/Function CKT or A19 LED and Lamp.	A16 or A17 Range/Function CKTs or A14 Transfer Pulse Generator CKT.	A17 Unit Decoder CKT or A19 Lamp.
A Unit is not lit but lighting point is correct.	A17 Range/Function CKT, A14 Transfer Pulse Generator or A19 LED and Lamp.	A17 Range/Function CKT or A19 LED and Lamp.	A17 Decimal Point Decoder, A14 Transfer Pulse Generator CKT or A19 Lamp.	A17 Unit Decoder CKT or A19 Lamp.
Every Unit is lit but incorrectly.	A16 or A17 Range/Function CKT, A14 Transfer Pulse Generator or A19 LED and Lamp.	A17 Unit/Decimal Point Decoder CKT or A19 LED.	A17 Range/Function CKT, A14 Transfer Pulse Generator CKT or A19 Lamp.	A17 Unit Decoder CKT.
All Units displays are correct.	A17 Decimal Point Decoder CKT, A14 Transfer Pulse Generator or A19 LED.	A17 Decimal Point Decoder CKT or A19 LED.	A17 Decimal Point Decoder CKT or A14 Transfer Pulse Generator CKT.	GO TO paragraph 8-59(3).

Figure 8-19. Troubleshooting from Unit/Decimal Point Display.

8-43. Option 004.

8-44. The block diagram of Option 004 Parameter Serial BCD Output is shown in Figure 8-10. Option 004 is an interface option which transfers C/L and G/R/D data from 4271B to a digital recorder. Data, Out of Range, Minus, Unbal and D⟶G information transferred from 4271B through latch memory and decoder to recorder. The Print Command signal (+PC) is generated by an END signal and directs printing. A +INHIBIT signal is routed from recorder to 4271B by leading edge of +PC signal and rejects triggering of 4271B. G/R data is transferred after transfer of C/L data and the 4271B rejects generation of a Reset pulse and data is held during the two transfers (DTP + HOLD). Data Mult. and Unit signals are transferred through decoder and gated by signals G1 and G2. G1 and G2 signals are generated by DTP + HOLD, CXfer, INHIBIT, Sample Rate and RESET signals and instructs transfer timing of Unit and Data Mult. signals depending upon transferred data (C/L or G/R/D).

8-45. Option 101.

8-46. The Block diagram of option 101 HP-IB Interface is shown in Figure 8-11. The Hewlett-Packard Interface Bus (HP-IB) is a carefully defined instrumentation interface which simplifies the integration of instruments, calculators, and computers into systems. The HP-IB employs a 16-line Bus to interconnect up to 15 instruments. Normally, this Bus is the sole communication link between the interconnected units. Each instrument on the Bus is connected in parallel to the 16 Bus lines. Eight of the lines are used to transmit data while the remaining eight lines are used for communication timing (Handshake) and control. Data is transmitted on the eight data lines as a series of eight-bit characters ("bytes"). Normally, a seven-bit ASCII code is used with the eight bit available for a parity check. Data is transferred by means of an interlocked "handshake" technique which permits asynchronous communication over a wide range of data rates. Figure 8-12 illustrates the HP-IB interface connections and overall Bus structure. Bus communication is controlled by the five general interface management (control) lines. These lines determine how information will be interpreted by devices on the Bus. The data bus (lines DIO1 through DIO8) is used to transfer information between devices on the Bus. The three data byte transfer control (handshake) lines permit synchronization of the data transfer on the data bus.

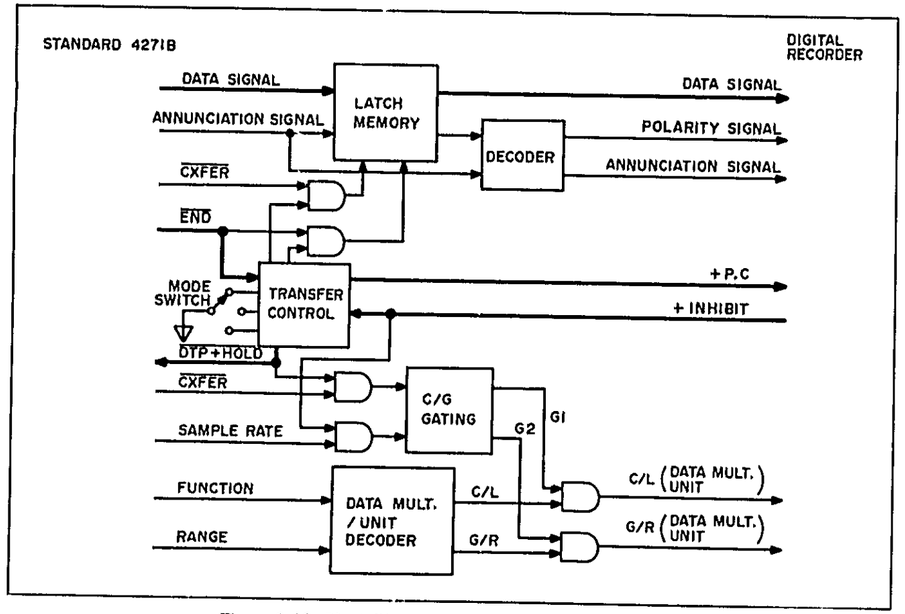


Figure 8-10 Block Diagrams of A25 and A26 (Option 004).

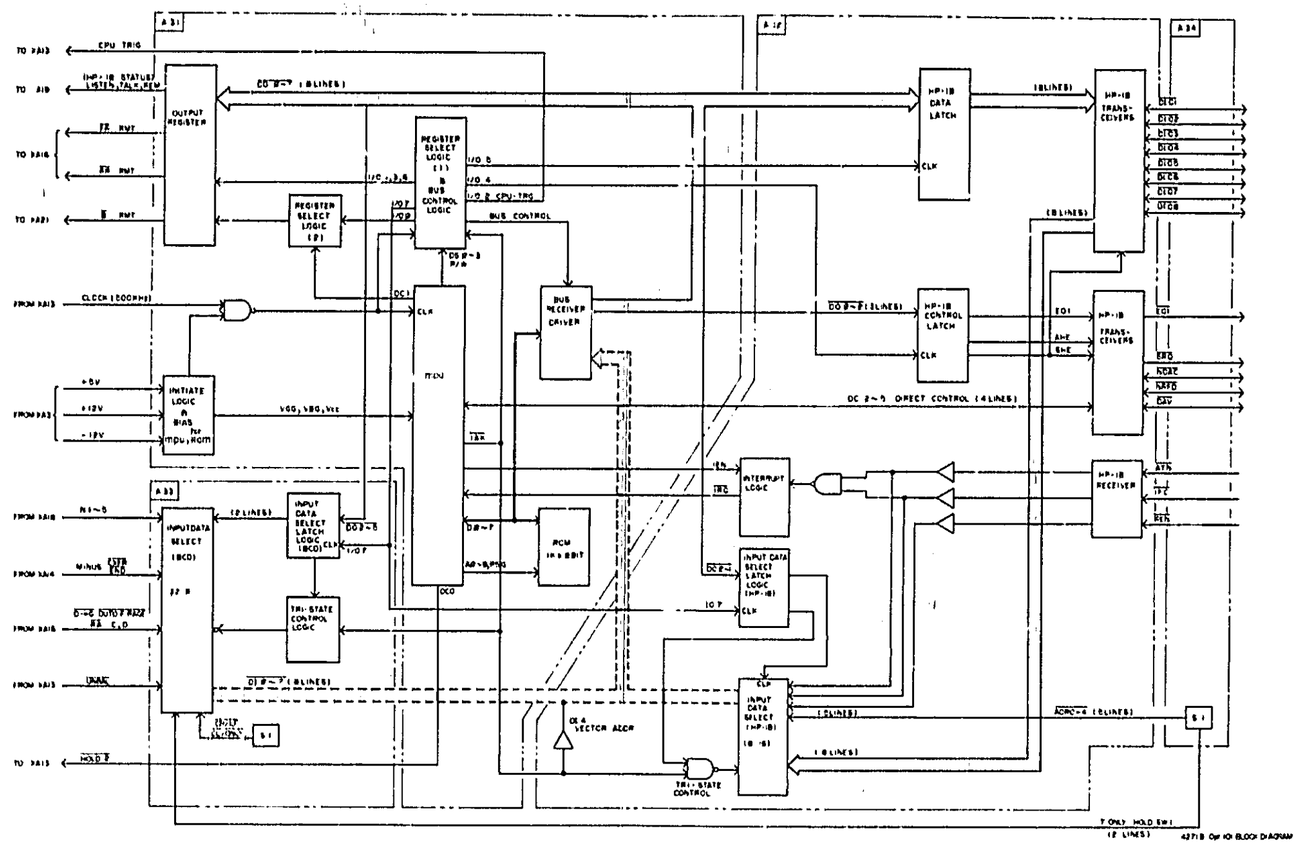


Figure 8-11. Block Diagram of Option 101 HP-IB Interface.

Figure 8-12
Interface Connections and Bus Structure.

SEE INSIDE

OUT OF RANGE lamp should be lit. If not, follow Figure 8-20.

(3-3) D►G, R lamp. Model 4271B Setup:

UNKNOWN ..... SHORT
RANGE 4
FUNCTION ..... L-D

D►G, lamp should be lit in above set-up. If not, follow Figure 8-21.

8-60. Troubleshoot according to Figure 8-22.

NOTE

Model 4271B has a terminal (J9) which is used as +5V power supply for logic probes and logic pulser. Refer to Figure 8-36.

8-61. Troubleshooting from display conditions. Model 4271B settings:

FUNCTION ..... C-G
RANGE 3
TRIGGER ..... INT
UNKNOWN ..... ≒1000pF

Check unit according to Figure 8-23.

8-62. Auto range check.

a. Remove A6 and A7.

b. Set RANGE to MANUAL 1.

c. Check waveforms at A17TP4, A17TP5, A16-TP2 A16TP3 with an oscilloscope to determine if they satisfy following equation:

If the Signal at A16TP2 is P2, and
Signal at A16TP3 is P3, and
Signal at A17TP4 is P4, and
Signal at A17TP5 is P5, then:

Then $P3 = P2 \cdot P5 + \overline{P2} \cdot \overline{P4}$.
If satisfied, check A17. If not, Check A16U5.

8-63. Troubleshooting Guide for Digital Section.

8-64. This Digital Section troubleshooting guide should be used independent and supplementary to the main procedures in Paragraphs 8-57 to 8-62.

a. Set 4271B as follows:

FUNCTION ..... C-G
RANGE..... AUTO
TRIGGER ..... RMT/MAN
REMOTE TRIGGER .. Connect to Pulse Generator.

b. Remove A6 and A7 boards.

c. Trigger 4271B with Pulse Generator and check A15TP1 thrugh 8 (STEPS 1 thru 8). Following four cases are possible:

(i) No STEP signal can be seen: Check voltage at

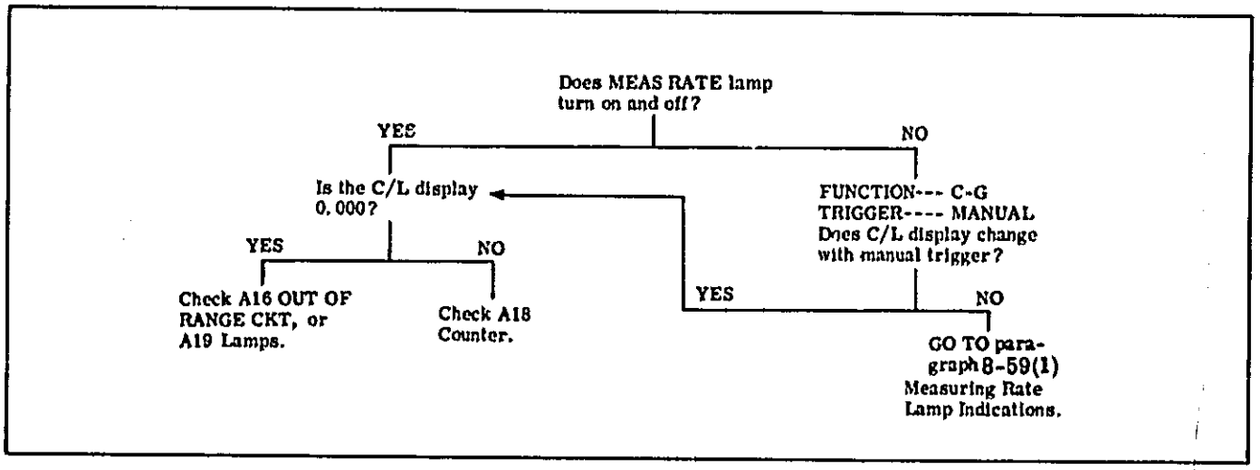


Figure 8-20. Annunciator Check (1).

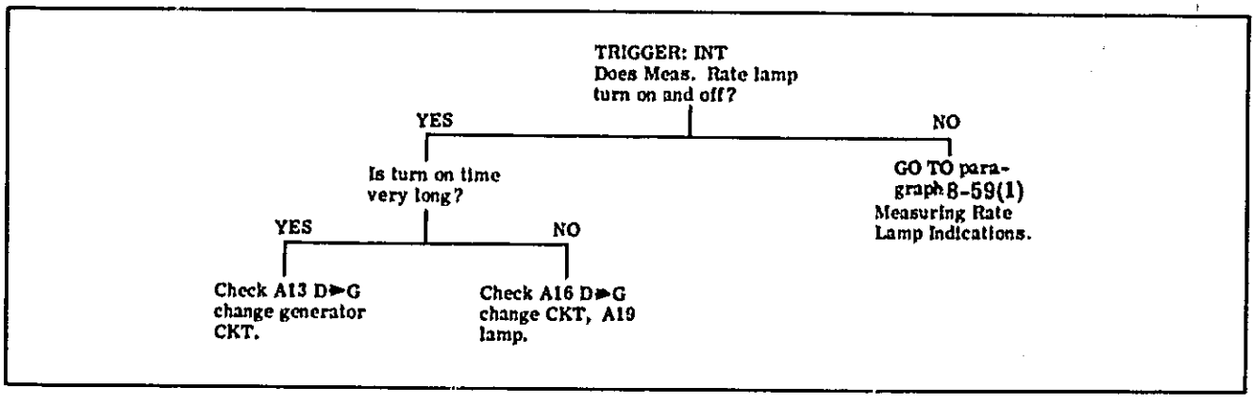


Figure 8-21. Annunciator Check (2).

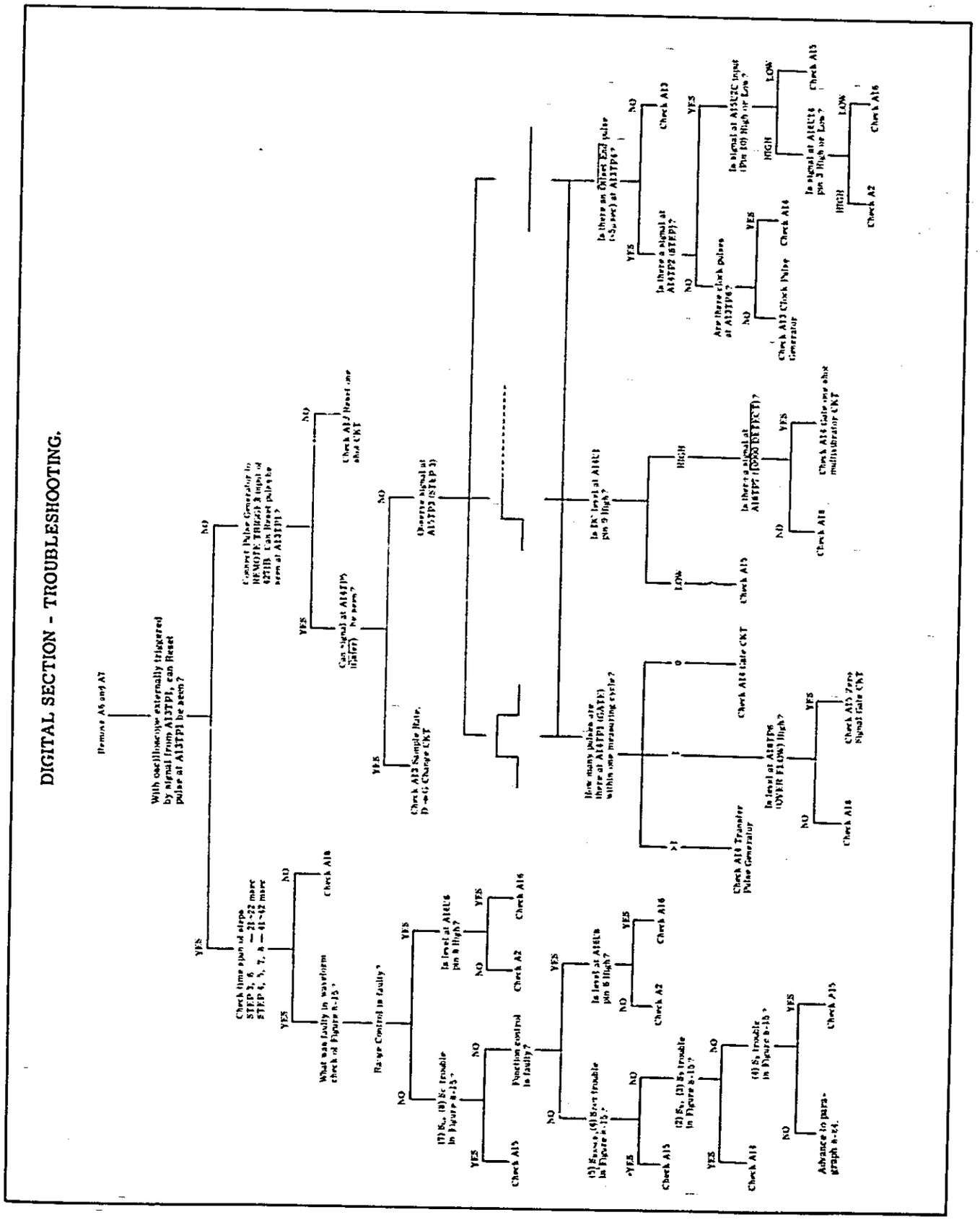


Figure 8-22. Troubleshooting Diagrams for Digital Section.

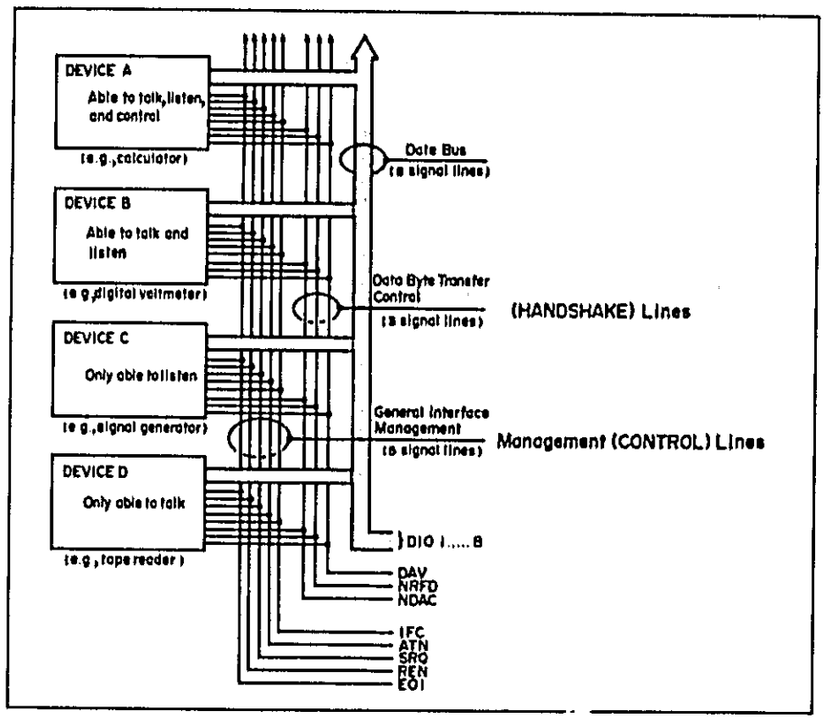


Figure 8-12. Interface Connections and Bus Structure.

8-47. TROUBLESHOOTING.

CAUTION

THE OPENING OF COVERS OR THE REMOVAL OF PARTS, EXCEED THOSE TO WHICH ACCESS CAN BE GAINED BY HAND, IS LIKELY TO EXPOSE LIVE PARTS. IN ADDITION, ACCESSIBLE TERMINALS MAY ALSO BE LIVE.

THE APPARATUS SHALL BE DISCONNECTED FROM ALL VOLTAGE SOURCES BEFORE ANY ADJUSTMENT, PARTS REPLACEMENT, OR MAINTENANCE AND REPAIR ARE PERFORMED FOR WHICH THE INSTRUMENT MUST BE OPENED. IF, AFTERWARDS, ANY ADJUSTMENT, MAINTENANCE OR REPAIR OF THE OPENED INSTRUMENT UNDER VOLTAGE IS REQUIRED, IT SHALL BE CARRIED OUT ONLY BY A SKILLED PERSON WHO IS AWARE OF THE HAZARD INVOLVED.

8-48. INTRODUCTION.

8-49. Troubleshooting procedures to board level of 4271B are contained in paragraphs 8-50 to 5-66. Troubleshooting to component level for each board assembly is described in SERVICE SHEET of each board. The troubleshooting outlined in this section should be done following flow as shown in Figure 8-13. If 4271B is used as an element of a system, the troubleshooting procedure should be applied only after determining that 4271B itself is at fault.

Note

The search for and locations of a faulty component in option 101 HP-IB Interface is done in accord with the troubleshooting flow diagrams in Figure 8-31. To facilitate an "easy to make" failure diagnosis, a "signature analysis" method was adopted for troubleshooting option 101 HP-IB Interface. When diagnosing with this method, a Signature Analyzer (HP 5004A) is necessary to property employ the procedures and associated signature maps (see service sheets). Refer to paragraph 8-69.

Board assemblies (which include option boards of 4271B) are classified into three general groups:

option board assemblies, analog section board assemblies, and digital board assemblies in standard instruments. The troubleshooting procedure for isolating the trouble to one of the three groups is explained in paragraphs 8-50 to 8-54. Procedures for troubleshooting to board level for a particular board assembly group is described in paragraphs 8-55 to 8-66. Theory of operation is covered in paragraphs 8-11 to 8-46 and, for quick and easy troubleshooting, should be well understood.

8-50. TROUBLESHOOTING TO BOARD ASSEMBLY LEVEL.

8-51. Troubleshooting procedure to isolate group which contains trouble from the three major board groups (option board assembly group, analog board assembly group or digital board assembly group) of a standard instrument is as follows: First treated is isolation procedure for option board assembly group, then analog board assembly group and digital board assembly group of a standard instrument. Thus, if instrument is not an option unit, isolation procedure paragraph 8-52 for option board assembly group paragraph 8-52 may be skipped (analog/digital isolation procedure is necessary).

8-52. Isolation Procedure for Option Board Group. Isolate Option Board Group by using procedure in Figure 8-14.

8-53. Isolation Procedure for Analog and Digital Circuits.

8-54. A method for isolation of Analog/Digital trouble using only 4271B front panel controls is described in Table 8-1. If Analog/Digital Isolation is not possible from Table 8-1, follow this sequence:

a. Turn LINE switch to ON.

b. Remove top cover from instrument.

c. Check power supply voltages:

A3TP1	+20V ±1V	to A GND
A3TP2	+10V ±0.05V	to A GND
A3TP3	-12V ±0.1V	to A GND
A3TP4	+5V ±0.2V	to D GND

If above check point voltages are not satisfactory, trouble is in Power Supply Section.

d. Check 1MHz oscillation at A4TP1 for: 1MHz ±100Hz, 0.7Vrms ±10%. If not within tolerance, trouble is in A4 Oscillator.

e. Remove A6 & A7 boards from instrument.

f. Set controls of monitoring oscilloscope to:

TIME/DIV 20msec/div
V/DIV 5V/div
TRIGGER ..... EXT with signal at A13TP1.

g. Check as follows:

Note

If any one check fails, a trouble is in Digital Section. If so, troubleshooting to board level (Digital Section) should be done. If all checks are correct, trouble should be in Analog Section.

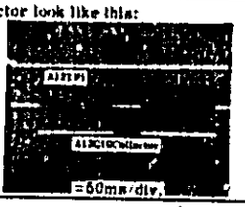
	SETUP	NORMAL DISPLAY	TROUBLESHOOTING
OUT OF RANGE LAMP	REMOVE A6 & A7 RANGE: 3 FUNCTION: C - D TRIGGER: INT	LIT	Is voltage at A16Q1 collector at low level? If OK, check A19 out of range lamp (DS15, 16, 17). If not, check A16.
D=G, R LAMP	FUNCTION: C-D RANGE: 4 TRIGGER: INT UNKNOWN DEVICE: ≤100pF	LIT	Check following: 1. Is waveform at A13U10 pin 12 the same as Reset pulse at A13TP1? 2. Is voltage level at A16Q2 collector at low level? If 1 and 2 are not satisfied, check A13. If 1 and 2 are satisfied, check A19 D=G, R lamp (DS21, 22). If 1 is satisfied and 2 is not satisfied, check A16.
DECIMAL POINT	Manually set RANGE and FUNCTION according to table on right.	RANGE FUNCTION: C-G 1 0.000 2 00.00 3 000.0	RANGE / A16TP2 / A16TP4 1 / LOW / LOW 2 / HIGH / LOW 3 / LOW / HIGH 4 / HIGH / HIGH FUNCTION / CHECK POINT / HIGH/LOW C - G / A16TP7 / HIGH A16L2 / LOW L - R / A16L1 / LOW A16L7 / HIGH L - D / A16L8 / HIGH Are all as above? NO → Check A16 YES → Check A17
UNIT	Every RANGE and FUNCTION	See Figure 3-5	Are there any blanks in display? NO → Go to troubleshooting of decimal point display YES → Check A19
(-) MINUS	FUNCTION: C - G RANGE: 1 UNKNOWN DEVICE: Open (Nothing connected). Set to minus (-) with OFFSET ADJ.	Minus (-) displayed on both displays.	Does DC voltage at A14U10 pin 3 change 5V to 0V with zero adjustment? NO → Check A14 YES → Check A19
UNBAL	Remove A11	LIT	Does voltage waveform at A13Q10 collector look like this:  If no, check A13 Unbal F/F. If yes, check A19 lamp DS19, 20.
UNBLANK CONTROL			Check A18. If either C/L or G/R Blanking is faulty, check LED.
NUMERIC DISPLAY	Remove A6, A7	0000 0000	Check overflow CKT. If overflow CKT is OK, check LED.

Figure 8-23. Troubleshooting from Display Conditions.

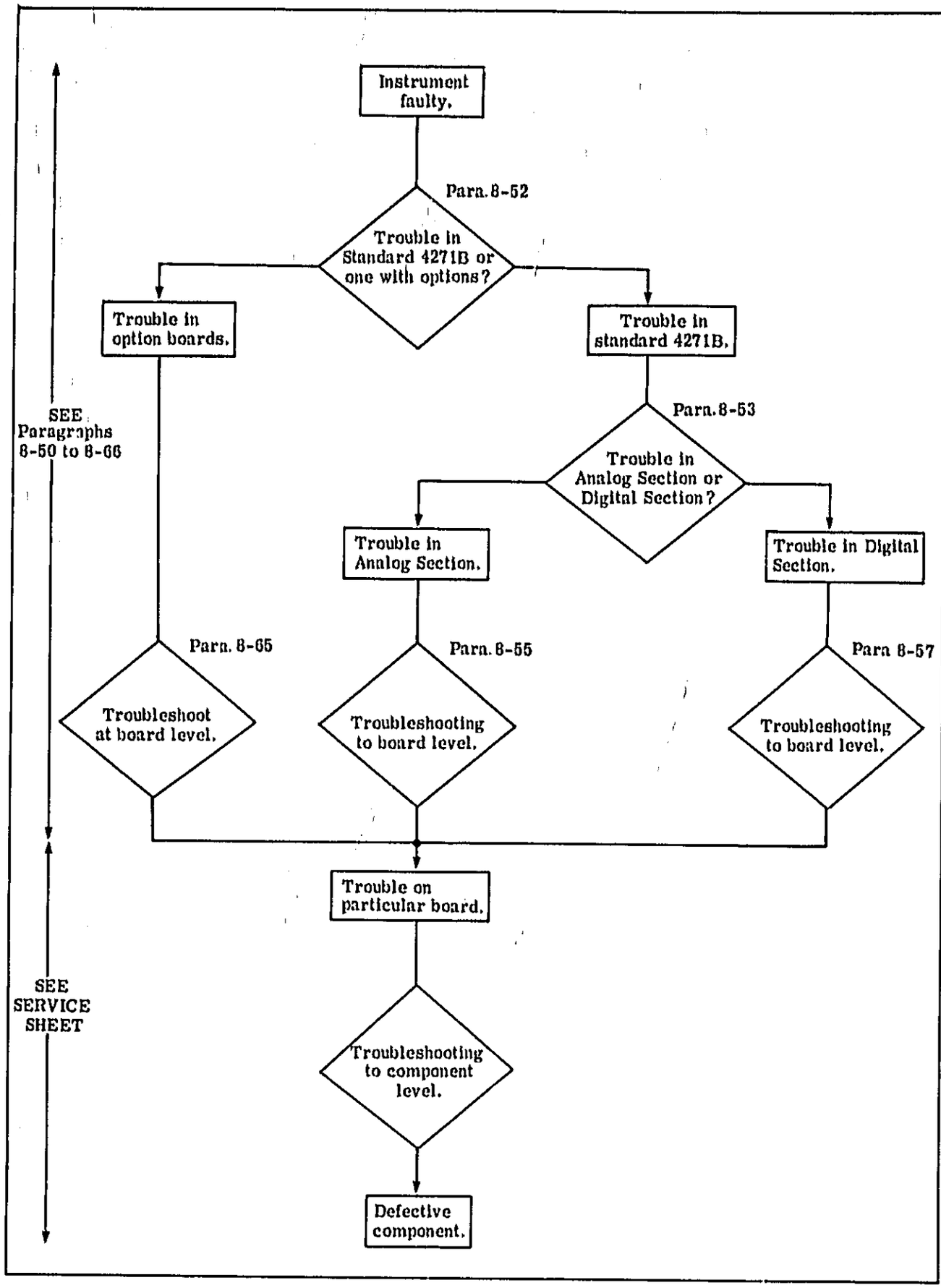


Figure 8-13. Model 4271B Trouble Isolation Procedure.

A13TP4 ($\overline{\text{OFFSET END}}$) and A14TP2 (STEP SHIFT). If both $\overline{\text{OFFSET END}}$ and STEP SHIFT exist, A15 board is faulty. If only $\overline{\text{OFFSET END}}$ signal exists, A14 is faulty. If both signals do not exist, A13 board is faulty.

(ii) Only STEP 1 signal can be seen (Refer to Figure 8-24): If STEP 1 signal is completed (≒21ms positive pulse), A15 board is faulty. If not, follow Figure 8-25.

(iii) Measuring Cycle is stopped at STEP 2 or beyond (Refer to Figure 8-26). Check A15 board.

(iv) When FUNCTION is set to C-D or L-D:

If STEP 6 signal is not completed, follow Figure 8-27.

8-65. Troubleshooting Guide for Option 004.

8-66. This paragraph contains troubleshooting procedures for isolating a defective board. Two procedures (with and without Digital Recorder) and described below. Troubleshooting to component level is described in Service Sheets.

a. When a Digital Recorder is connected to 4271B, troubleshoot in accord with Figure 8-28.

b. If Digital Recorder is not connected, troubleshoot as shown in Figure 8-29.

8-67 TROUBLESHOOTING TO COMPONENT LEVEL.

8-68. Troubleshooting guides are provided for each board assembly. These guides assume that only the suspected board is defective and that other boards are functioning correctly. Troubleshooting guides generally include the use of an oscilloscope. It is helpful (for easy observation of waveforms) to trigger oscilloscope externally with the 1MHz oscillation (A4TP1) when observing analog circuits and Reset pulse (A13TP1) or STEP Signals (A15TP1 thru 8) when checking digital circuits. For faster troubleshooting of IC's and logic circuitry, HP Models 10525T Logic Probe, 10528A Logic Clip, 10529A Logic Comparator, 10256T Logic Pulser and Model 5000A Logic Analyzer are suggested. Troubleshooting time will be considerable shortened by using one or more of these instruments instead of an oscilloscope.

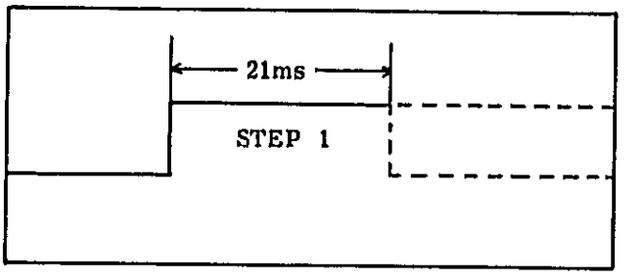


Figure 8-24. STEP 1 Signal.

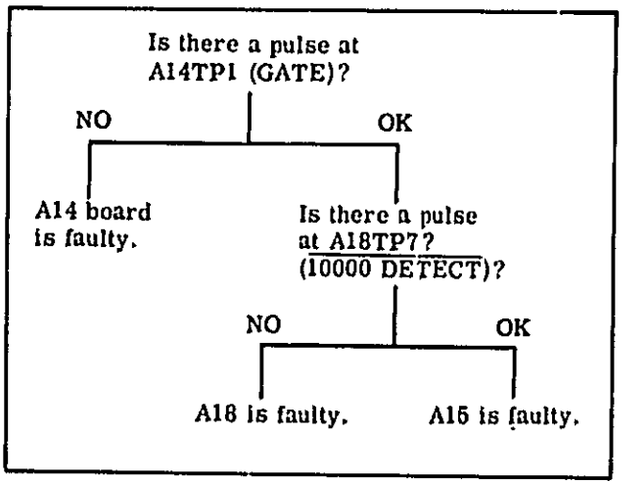


Figure 8-25. Isolation to Boards A14, A15 or A18.

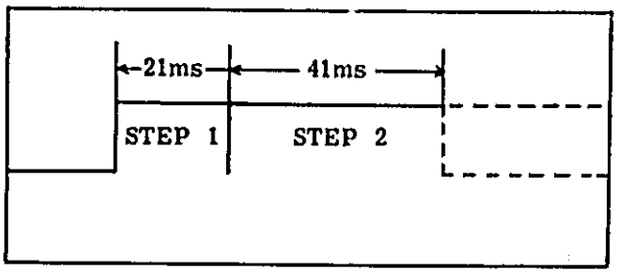


Figure 8-26. STEP 1 and 2 Signals.

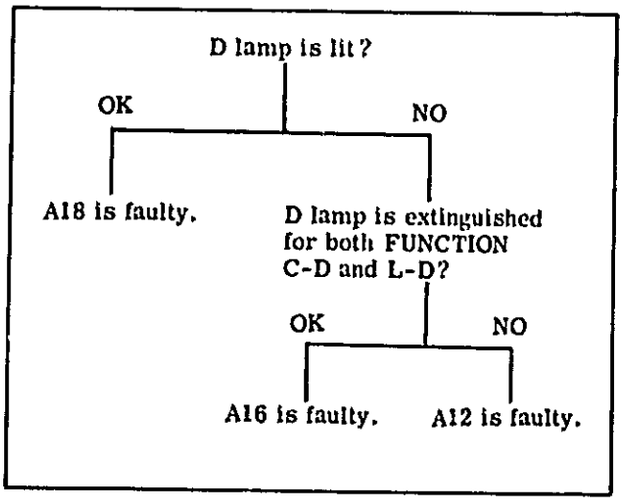


Figure 8-27. Isolation to Boards A12, A16 or A18.

Table 8-1. Front Panel Isolation Procedure.

	Probable Trouble is in Analog Section	Probable Trouble is in Digital Section
SYMPTOM	* "-200" and "0000" are mutually displayed. * Measured value changes widely when switching from HIGH to LOW setting of TEST SIG LEVEL. * Measured value is much different from value of unknown device.	* Abnormal unit display. * Abnormal decimal point display. * Zero blanking function is incorrect. * Measurement can be done in AUTO range but it can not be done in MANUAL range. * Measurement can be done in MANUAL range but it can not be done in AUTO range. * Display does not change after turning LINE to ON. * Always displays minus. * "OUT OF RANGE" lamp is lit in spite of displaying reasonable value for unknown device.

h. Set front panel controls of 4271B as follows:

FUNCTION ..... C-G
RANGE 3
TRIGGER ..... INT

i. Observe waveforms with oscilloscope. Waveforms at following points should be as shown in Figure 8-15 waveforms (1) to (8).

Note

Adjust 4271B RATE control and sweep vernier of oscilloscope for observing waveform of Reset Pulse at A13TP1 as shown in Figure 8-15 (1).

j. Range Resistor Control Check. Confirm that the level at each pin of A16U17 is high when RANGE is changed. See Table 8-2.

Table 8-2. Range Resistor Control Check.

RANGE	PIN NO. (HIGH LEVEL)
1	U 17 - 8
2	U 17 - 6
3	U 17 - 3
4	U 17 - 11

k. Function Control Check. Confirm that level of TP's are as shown in Table 8-3.

Table 8-3. Function Control Check.

FUNCTION	A16TP7	A17TP1
C - G/C - D	HIGH	HIGH
L - R/L - D	LOW	LOW

l. Display Check. Remove A11 board. Display should read:

C: 000.0pF
G: 0.000mS

"OUT OF RANGE" is lit.
"UNBAL" is turned on and off (alternately).
Measuring Rate lamp is turned on and off (alternately).

8-55. Troubleshooting to Board Level of Analog Section.

8-56. Figures 8-16 and 8-17 show troubleshooting procedure to board level for analog section of 4271B.

8-57. Digital Section Troubleshooting.

8-58. Troubleshooting Digital Section from front panel is covered in Paragraph 8-54. This procedure should only be used after completing Analog/Digital section isolation procedures (Paragraph 8-53).

Note 1

Troubleshooting from front panel is not always precise but provides a milking procedure which narrows down the trouble possibilities.

Note 2

Theory of operation of 4271B should be well understood for front panel troubleshooting procedure to be efective.

Note 3

If trouble area cannot be located with this procedure, follow general troubleshooting procedure in paragraph 8-63.

8-59. (1) Measuring Rate lamp indications. Troubleshoot according to Figure 8-18.

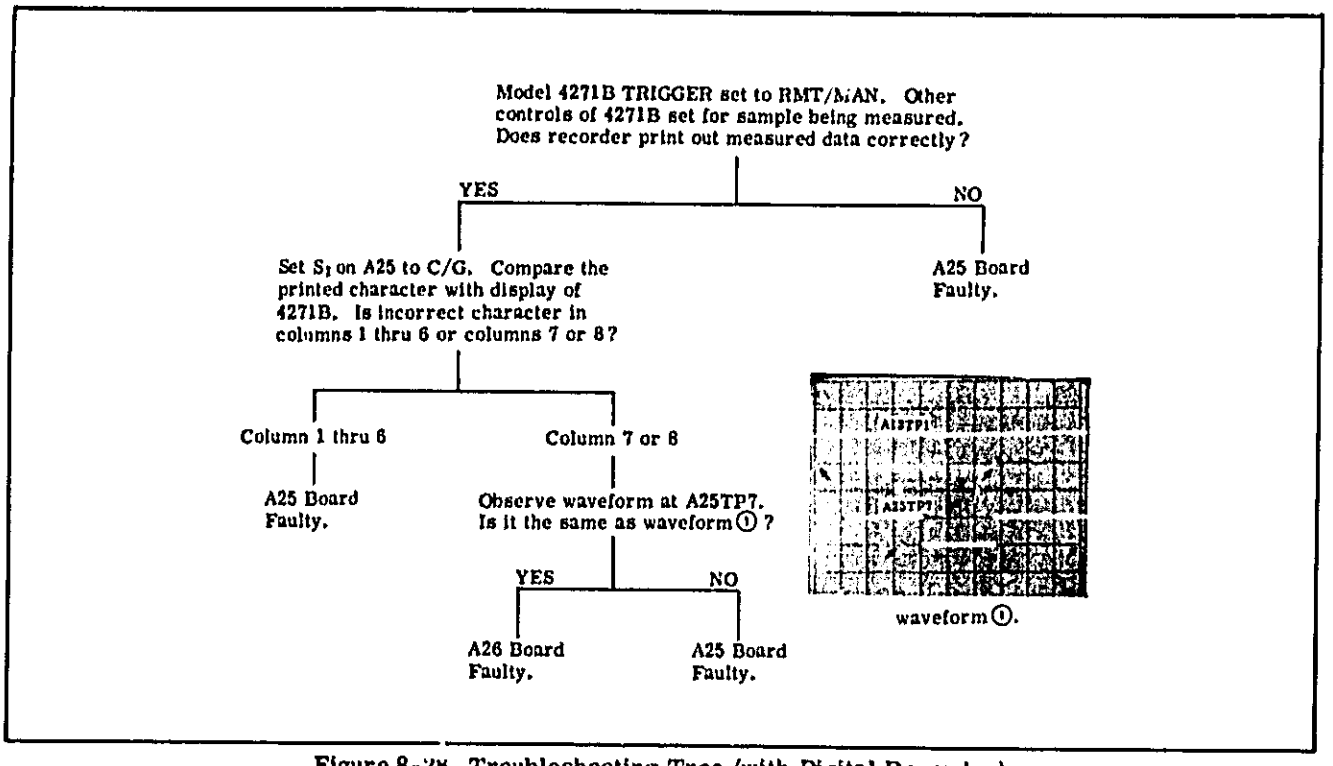


Figure 8-28. Troubleshooting Tree (with Digital Recorder).

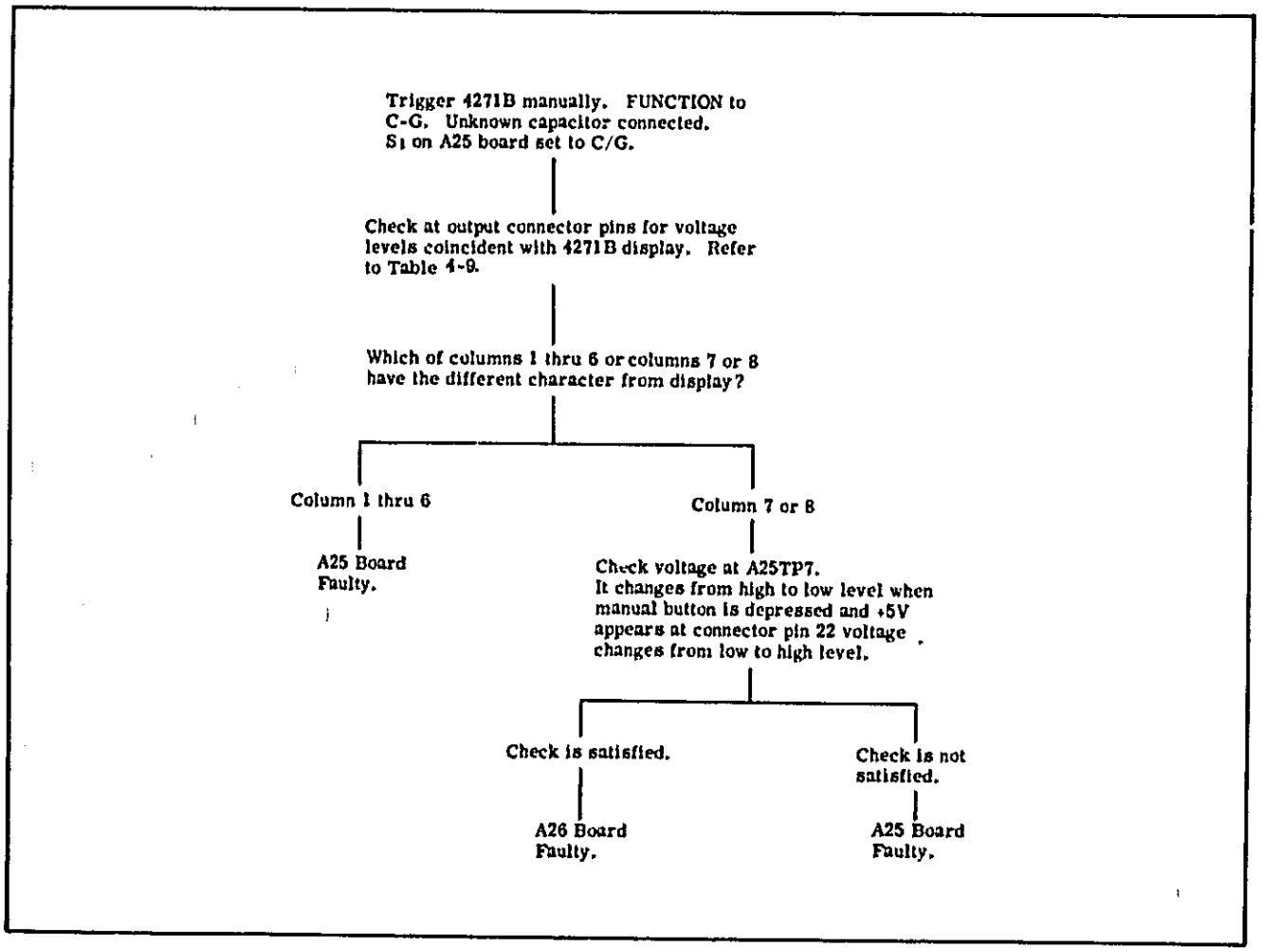


Figure 8-29 Troubleshooting Tree (without Digital Recorder).

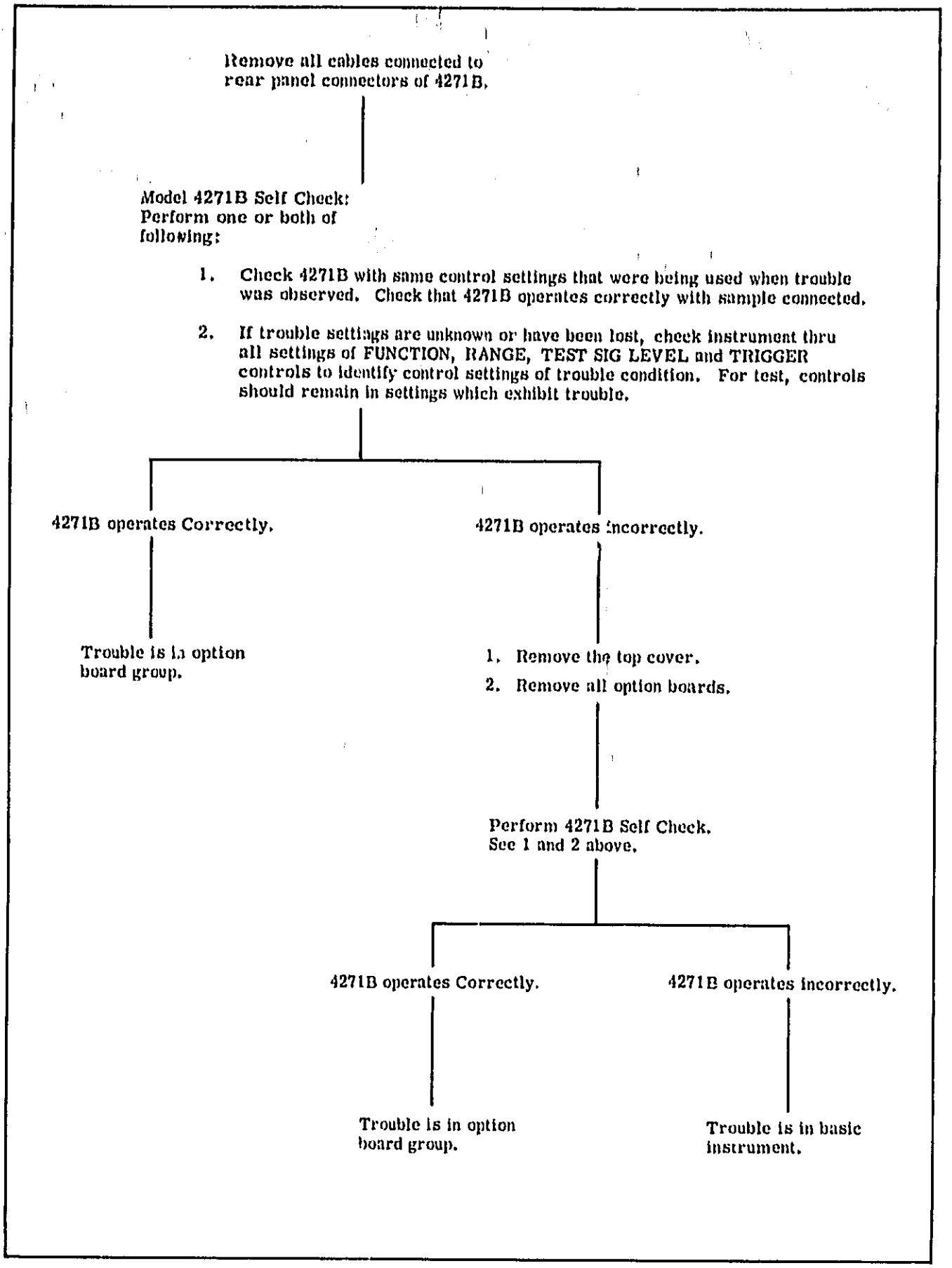


Figure 8-14. Group Isolation Procedure.

8-69. Troubleshooting Guide for Option 101.

8-70. Troubleshooting of Option 101 HP-IB Interface is using "Signature Analysis". The advantage of troubleshooting based on "Signature Analysis" is accuracy and ease in finding failures. It is generally difficult to search for an error by means of observing waveforms on an oscilloscope for the reason that bit trains in a digital circuit seem to be much the same whichever is observed. Specifically, to find the errors in stream of a large bit size (or word length) data takes much time and requires the use of an instrument such as a logic state analyzer. Hewlett-Packard has proposed a method called "Signature Analysis" which recognizes the bit pattern measured in a 4 digit hexa-decimal code (signature) for running an easy diagnostic test program. With the Signature Analyzer (HP 5004A), the signatures are displayed in a readable 4 digit-figure set of alphanumeric figures (0 1 2 3 4 5 6 7 8 9 A C F H P U). The signature analysis is based the usual signal tracing method followed in troubleshooting an analog circuit. According to signature analysis, devices in a digital circuit are checked with the signal analyzer by comparing signal input and output signatures to and from each device for the "correct" signature denoted in the service manual signature map. If a signature is not identical, the troubleshooter need only trace the bit train in opposite direction to the signal flow and, when a device is noted which generates an erratic signature despite a correct input, the component may be regarded as faulty. Refer to Figure 8-30 for "Signature Analysis" guidelines.

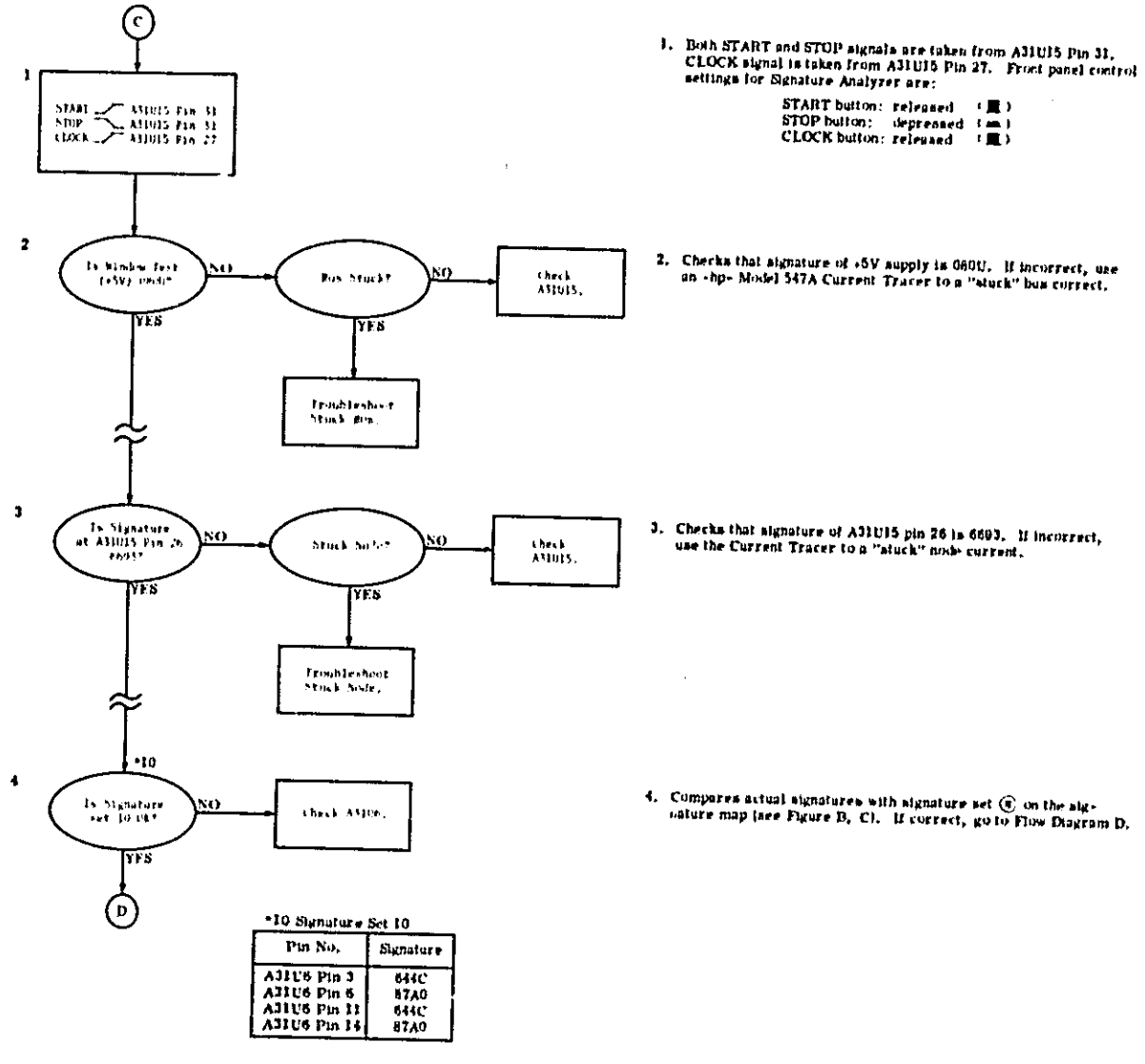


Figure A. Diagnostic Flow Diagram Notes.

Figure 8-30. Signature Analysis Guide (Sheet 1 of 2).

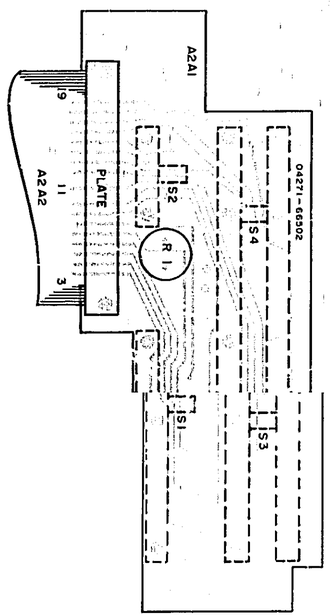


Figure 8-37. A2 Control Switch Board Assembly Component Locations.

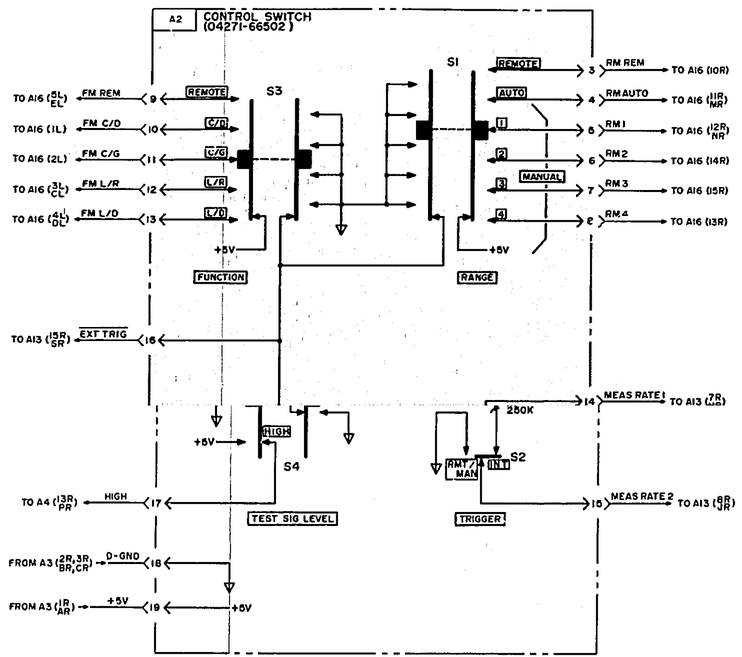


Figure 8-38. A2 Control Switch Board Assembly Schematic Diagram.

SIGNATURE ANALYZER TECHNIQUE

An active digital hand-held logic tracer coupled with an active pod (with four miniature clip connection leads) is sufficient for detecting the test signal and for development of the signature on the Signature Analyzer display. The active probe has access to the desired node in the circuit being tested and transfers this input data to the analyzer. The four input leads of the test cable active pod, connect the gate signals - START, STOP, and CLOCK - from the instrument being tested to the analyzer. The remaining lead is connected to instrument GND. The START signal is an open "window" (measurement gate) signal which causes the signature analyzer to prepare for receiving data via the active probe. The STOP signal causes the window to close. The CLOCK is taken from the time base of the instrument and permits receiving input data and gate signals in synchronization. Polarity of the gate signal active (enable) edges (positive or negative) can be selected by the front panel controls of the signature analyzer. Probing points and connection locations of START, STOP and CLOCK leads are designated on the troubleshooting flow diagrams.

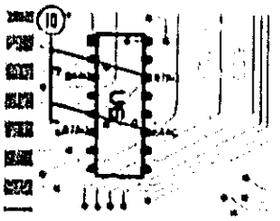


Figure B. Signature Map Notes on Component Locations.

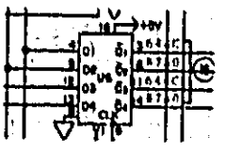


Figure C. Signature Map Notes on Schematic Diagrams.

Figure 8-30. Signature Analysis Guide (Sheet 2 of 2).

Figure 8-31. HP-IB Interface Troubleshooting Procedures 8-29
Flow Diagram A. Initial Check 8-29
Flow Diagram B. ROM Test 8-29
Flow Diagram C. Bus Output Test (A31 Board) 8-30
Flow Diagram D. Bus Output Test (A32 Board) 8-32
Flow Diagram E. Bus Output Test (A33 Board) 8-32
Flow Diagram F. Bus Input Test (A33 Board) 8-33
Flow Diagram G. Bus Input Test (A32 Board) 8-34
Flow Diagram H. Interrupt Test 8-35

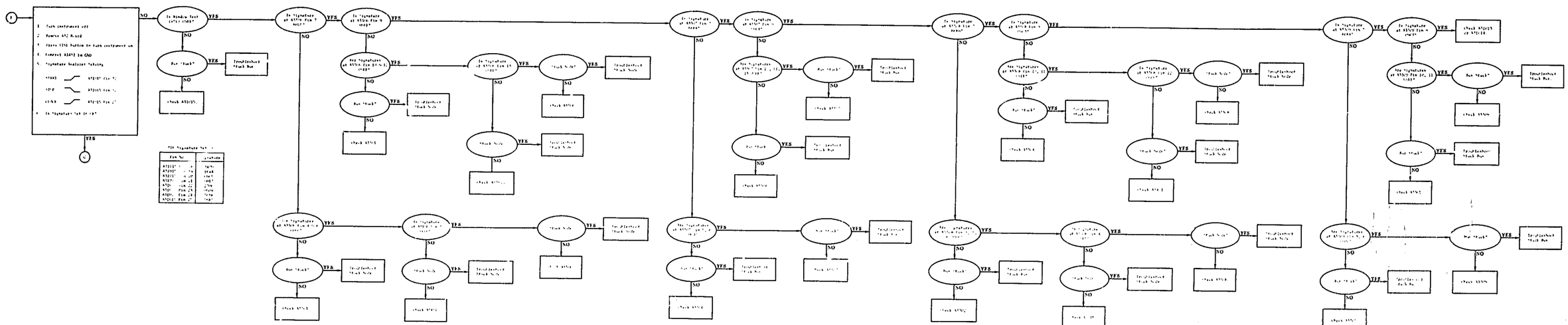


Figure 8-31. HP-IB Interface Troubleshooting Procedures.
Flow Diagram F. Bus Input Test (A33 Board).

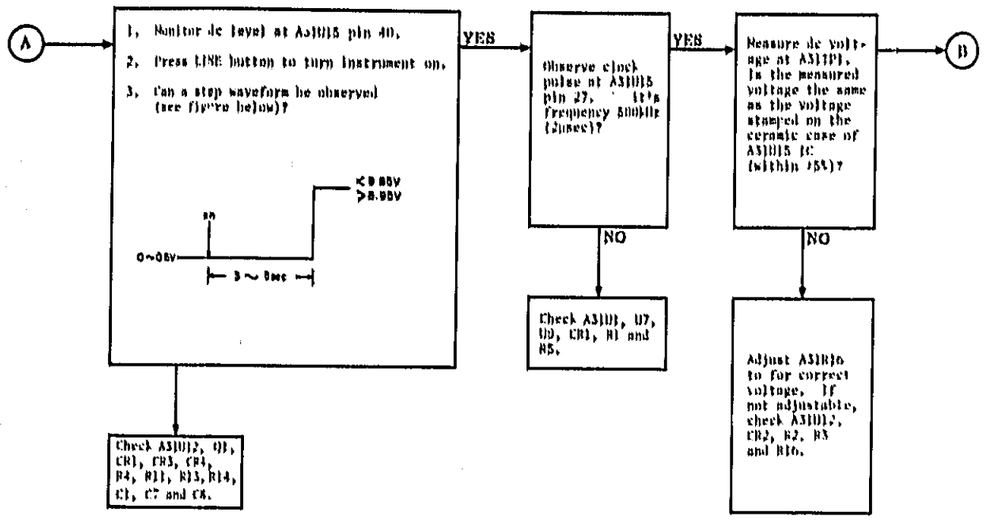


Figure 8-31. HP-IB Interface Troubleshooting Procedures, Flow Diagram A. Initial Check.

Table A. Program ROM (A3U16) Test Signatures.

HP Part No.	Window test (+5V)	D0	D1	D2	D3	D4	D5	D6	D7
04271-85001	8P54	4P16	P798	U8U1	3PH0	2C13	84H1	6982	CA14

Table B. Signature Program ROM Test Signatures.

HP Part No.	Window test (+5V)	D0	D1	D2	D3	D4	D5	D6	D7
04271-85002	8P54	2521	P9C0	U84P	U2C0	0U13	F1A6	04A0	3105

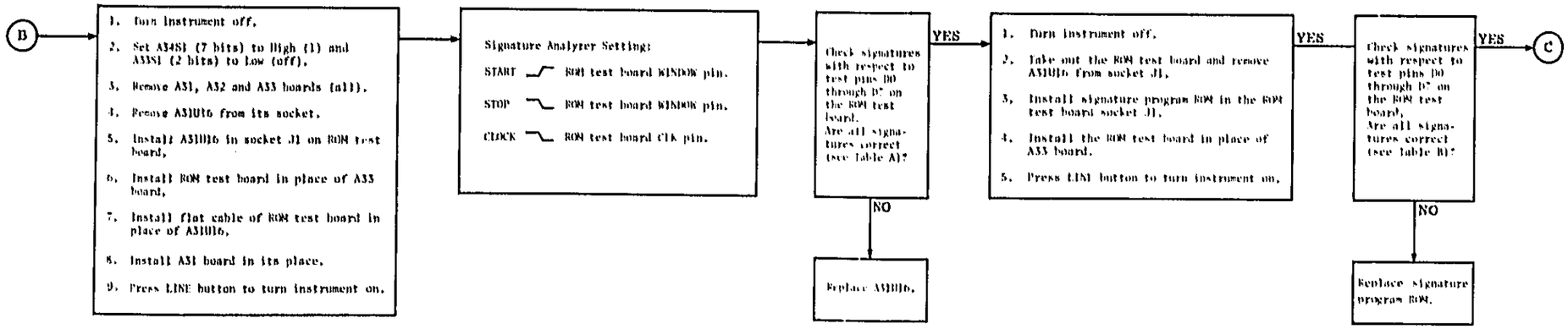


Figure 8-31. HP-IB Interface Troubleshooting Procedures, Flow Diagram B. ROM Test.

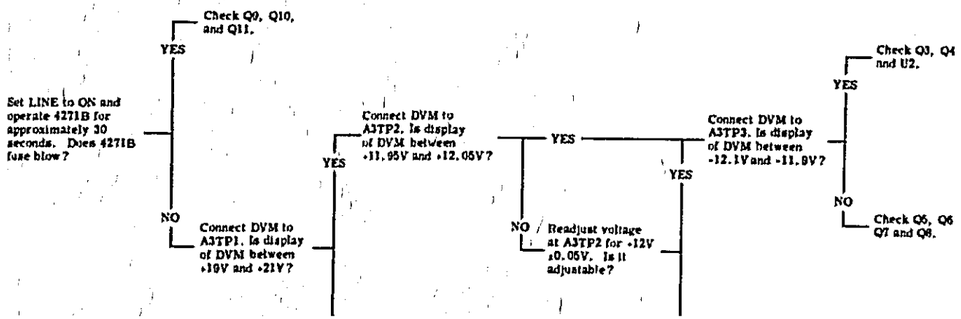


Figure 8-39. A3 DC Power Supply Board Troubleshooting Tree.

A3 BOARD CIRCUIT DESCRIPTION

Figure 8-40 is the block diagram of A3 DC Power Supply. The ground terminal of the +50V, 20V, -20V, +12V and -12V supply is the "A. GND" (ground for analog circuit) and the ground terminal of +5V supply is "D. GND" (ground for digital circuit). Ground terminals of analog boards connect with A. GND. Ground terminals of digital boards connect with D. GND. D. GND also connects with A. GND on the A3 board, and they, in turn, are connected to the chassis. When the +12V and +5V outputs increase beyond 25V and 6.7V, respectively, the voltage protector circuit opens fuse F1. In addition, if the output of the +12V and +5V supplies are accidentally shorted. a current protector circuit opens the +12V and +5V outputs by turning off Q2 and Q3, respectively.

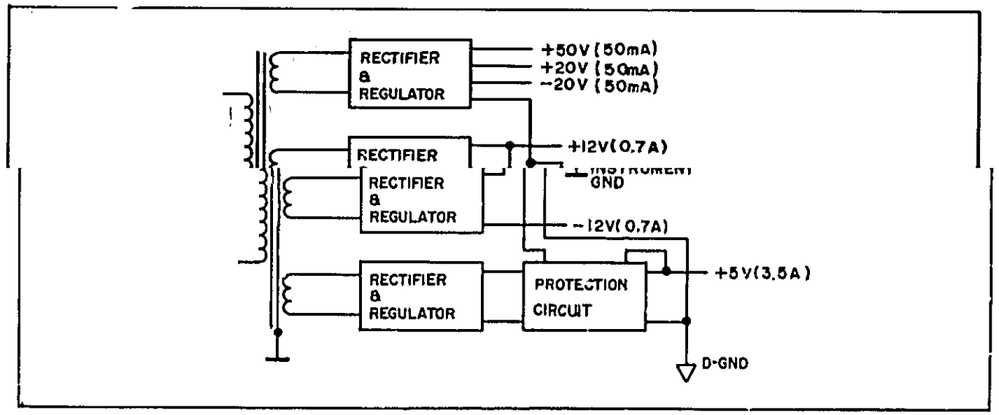


Figure 8-40. Block Diagram of A3 Board.

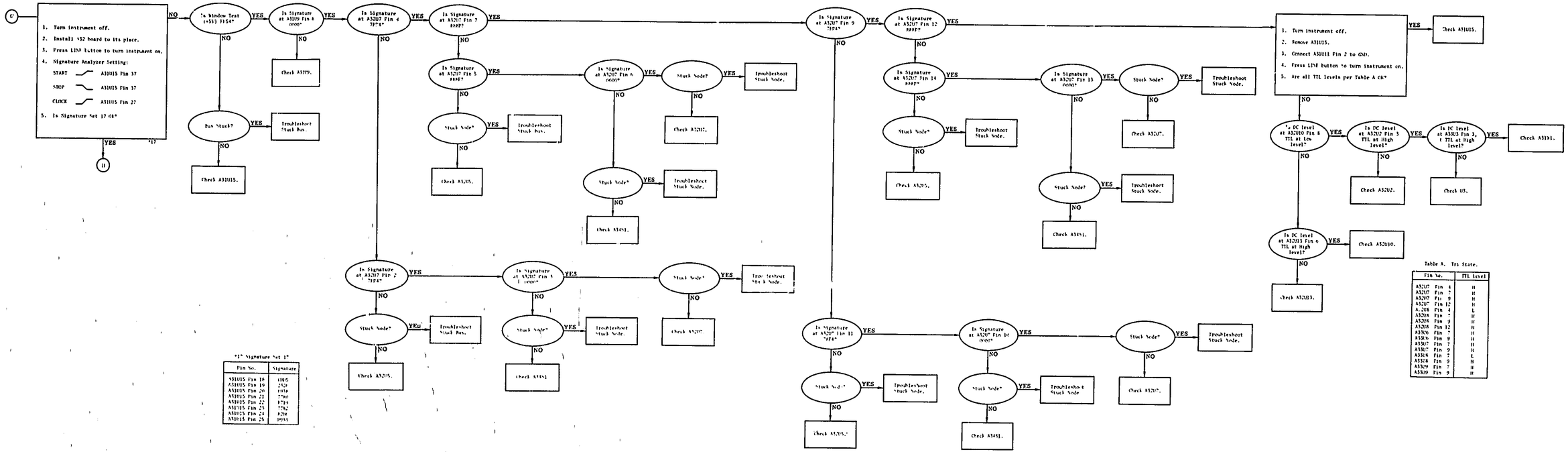


Figure 8-31. HP-IB Interface Troubleshooting Procedures, Flow Diagram G. Bus Input Test (A32 Board).

Figure 8-31
HP-IB Interface Troubleshooting Procedures
Flow Diagram F
SEE INSIDE

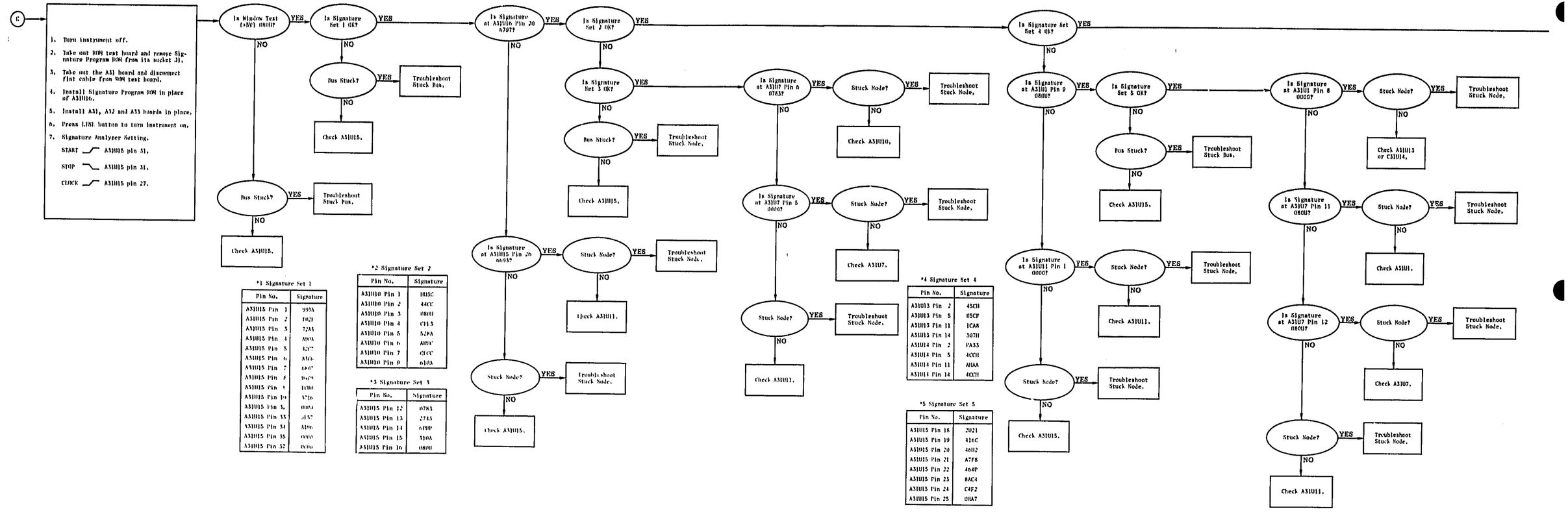


Figure 8-31. HP-IB Interface Troubleshooting Procedures, Flow Diagram C. Bus Output Test (A31 Board).

SEE INSIDE

Figure 8-31
HP-IB Interface Troubleshooting Procedures
Flow Diagrams A and B

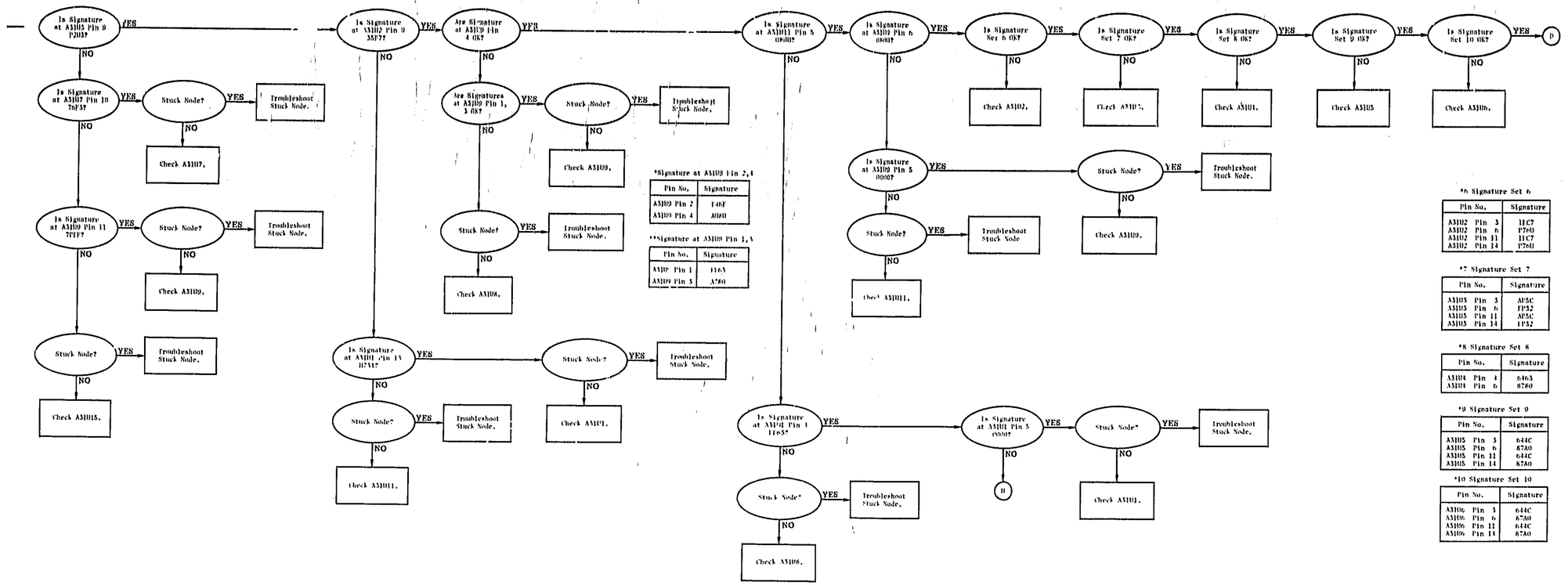


Figure 8-31. HP-IB Interface Troubleshooting Procedures, Flow Diagram C. Bus Output Test (A31 Board).

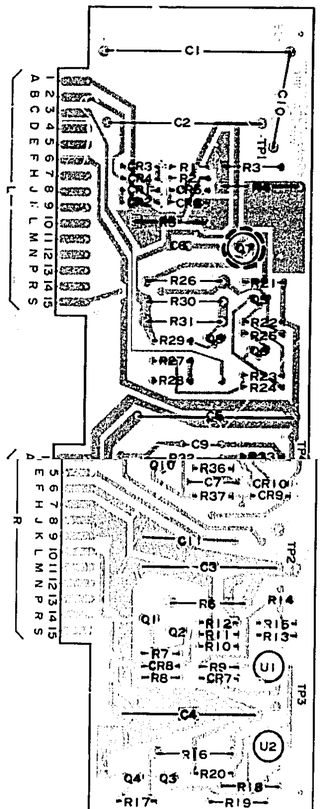


Figure 8-41. A3 DC Power Supply Board Assembly Component Locations.

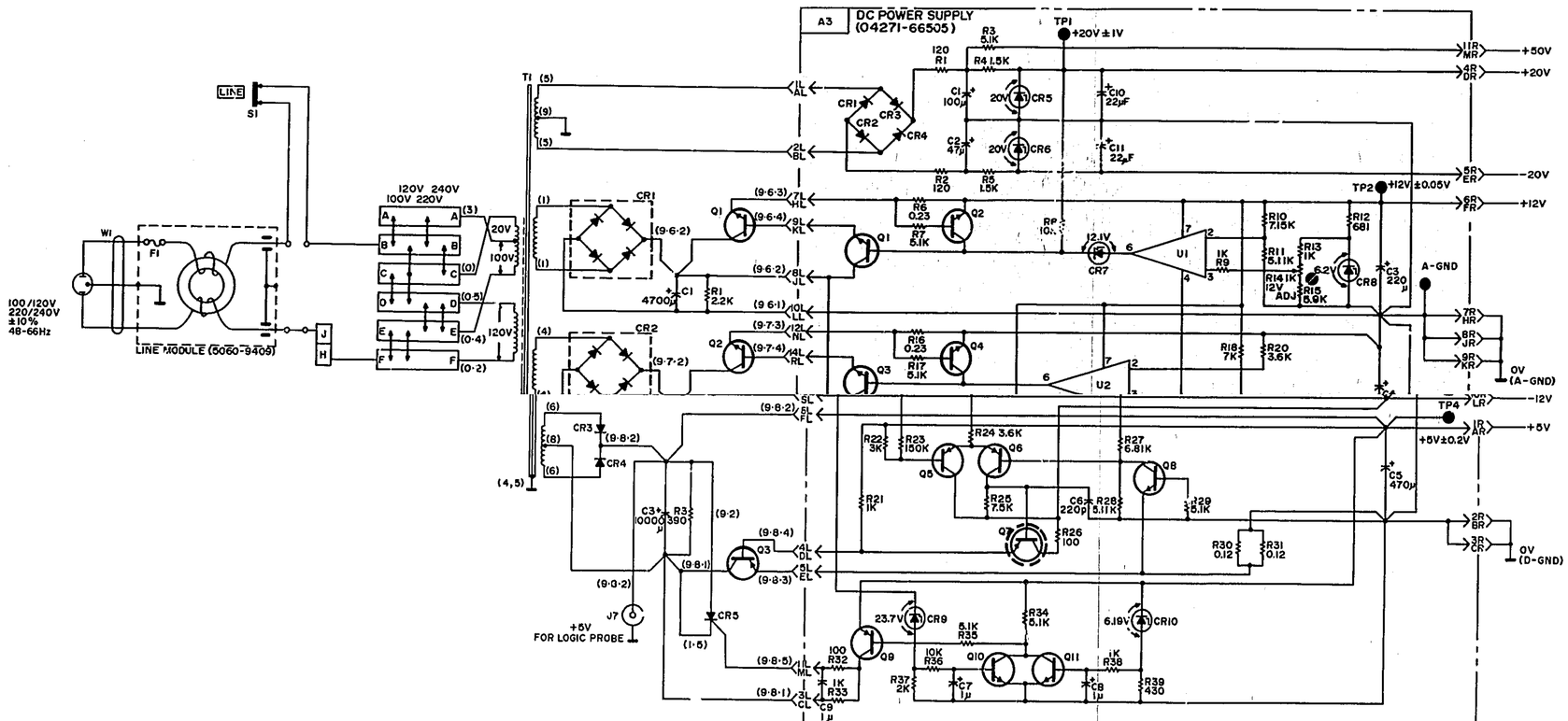


Figure 8-42. A3 DC Power Supply Board Assembly Schematic Diagram.

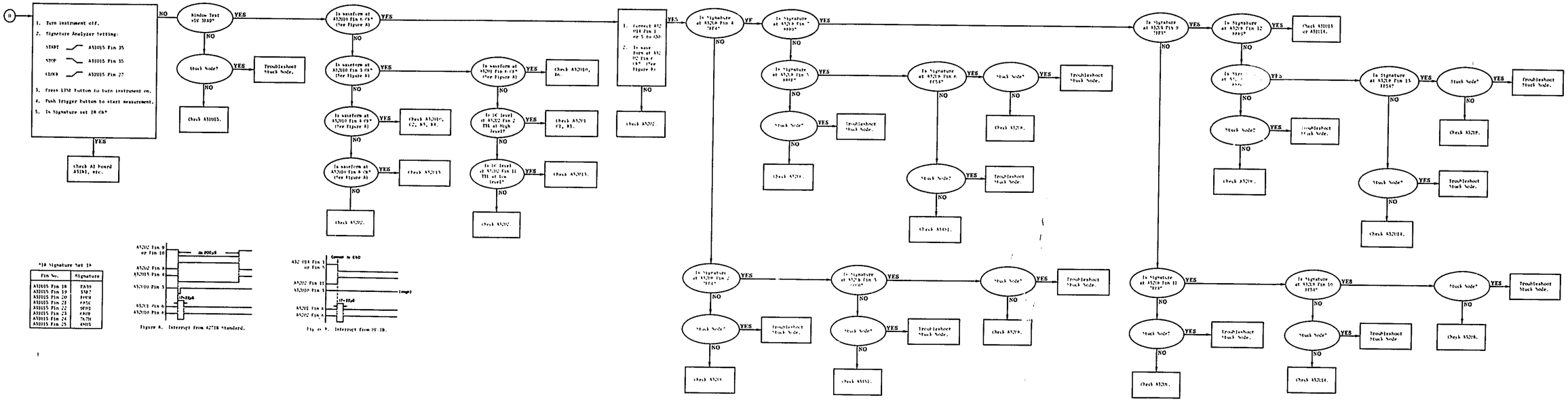
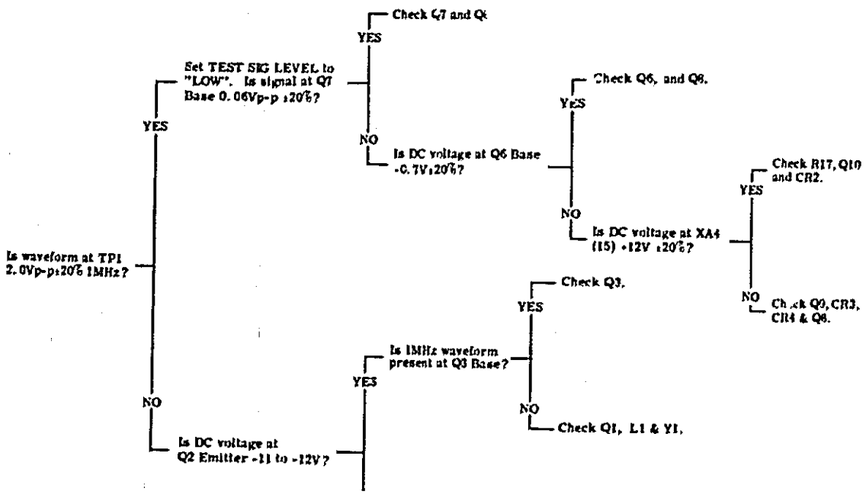


Figure 8-31. HP-IB Interface Troubleshooting Procedures.
Flow Diagram H. Interrupt Test.



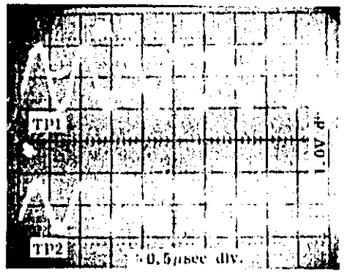


Figure 8-43. A4 Oscillator Board Troubleshooting Tree.

A3 DC Power Supply SERVICE SHEET 3
SEE INSIDE

A4 BOARD CIRCUIT DESCRIPTION

Figure 8-44 is a block diagram of the A4 Oscillator. The output circuit of the 1MHz Quartz Oscillator is an Emitter Follower. The signal from Q3 Emitter controls the peak detector to stabilize output level of the oscillator. This 1MHz signal is transmitted to A8 Modulator, to A13 Reset/Clock Pulse Generator and also transmitted to A9 Power Amplifier through Emitter Follower Q7.

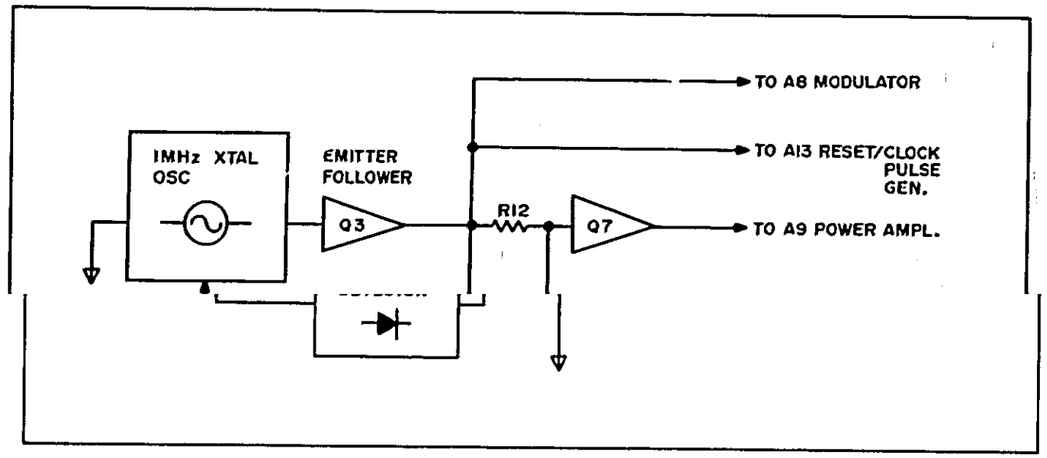


Figure 8-44. Block Diagram of A4 Board.

8-71. DISASSEMBLY.

8-72. A1 Mother Board disassembly (refer to Figure 8-32).

a. Remove the four screws and lift off top cover.

b. Remove shield plate for A11 and A12 boards.

c. Take out all PC boards except A2 board.

NOTE

Connection plate of A2 assembly should be disconnected.

d. Disconnect four pin connectors (located inside center of rear panel) from A1 Mother board.

NOTE

Label connecting cables as to color codes for identification when reassembling.

e. Remove the four screws and take off bottom cover.

f. Disconnect 12-pin connector from OFFSET ADJ. potentiometer to A1 Mother board.

g. Disconnect 2 wires from REMOTE TRIGGER terminal to A1 Mother board by unsoldering.

h. Remove the 2 screws fastening 30-pin connector from power supply section to A1 Mother board.

i. Remove 23 screws fastening A1 Mother board to chassis.

j. Reverse above procedures for reassembly.

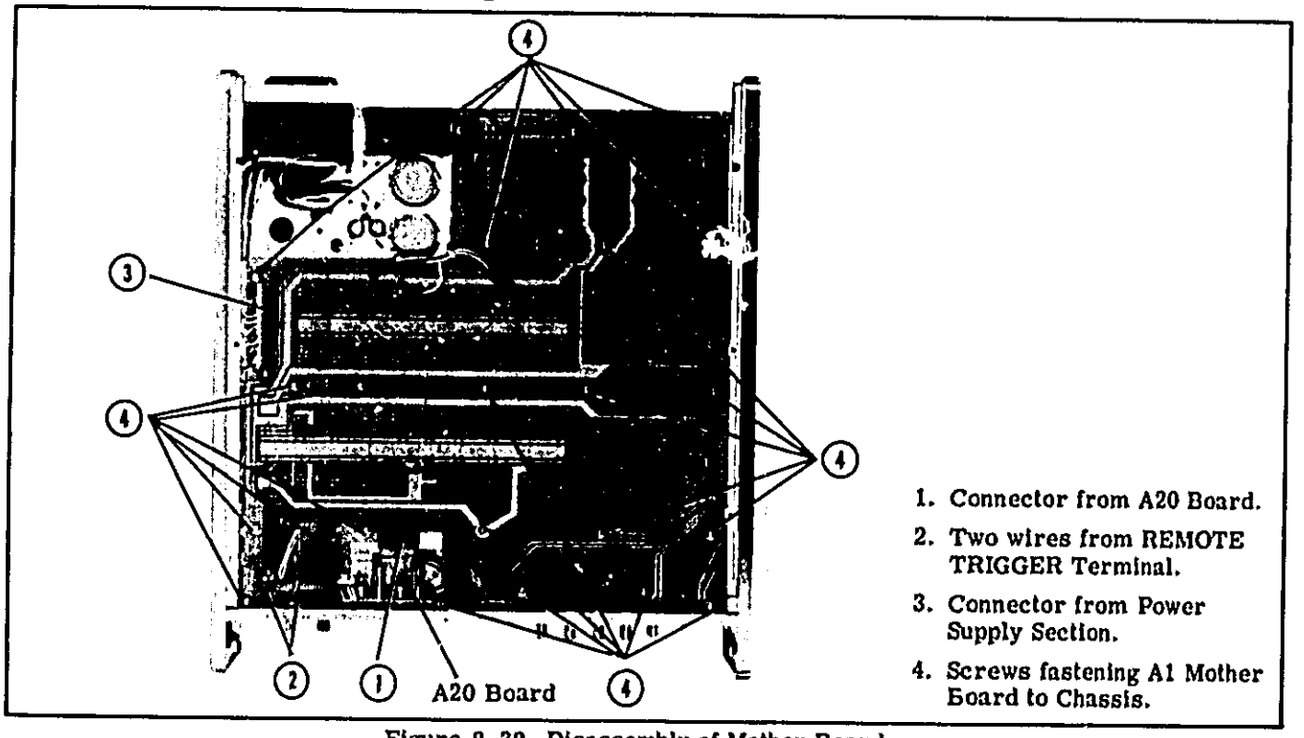


Figure 8-32. Disassembly of Mother Board.

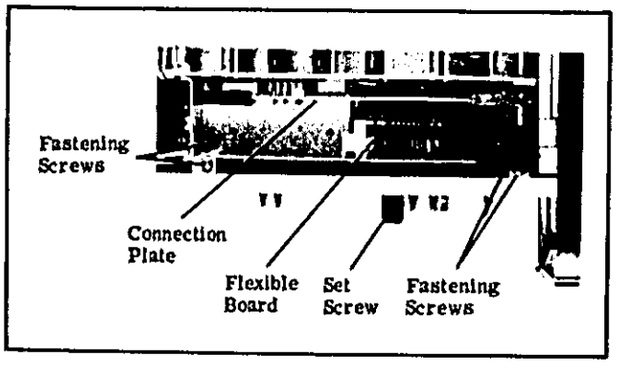


Figure 8-33. Disassembly of Switch Assembly.

8-73. A2 SW Control disassembly (refer to Figure 8-33).

a. Remove the four screws and lift off top cover.

b. Remove two set screws from RATE control on front panel.

c. Remove four screws fastening A2 board assembly to chassis.

d. Loosen connection plate from A1 Mother board connector.

e. Lift out connection plate and A2 assembly from instrument at the same time.

f. Reverse steps a through e for reassembly.

8-74. Replacement of Q3.

a. Remove top and bottom covers from instrument.

b. Remove the four screws and take off left side cover.

c. Remove 4 screws fastening heat sink of Q3 to side frame.

d. Loosen six screws fastening left side frame to chassis.

e. Take Q3 with heat sink out of side frame.

f. Unsolder wiring to Q3.

NOTE

Color code of wiring to Q3 should be identified for reassembly.

g. Replace Q3 with new transistor.

h. Reverse steps a to g for reassembly.

8-75. Replacement of Q1, Q2 and CR5.

a. Remove right side cover.

b. Remove two screws fastening Q1, Q2 or CR5 to chassis.

c. Replace Q1, Q2 or CR5.

d. Reverse above procedure for reassembly.

8-76. PRODUCT SAFETY CHECKS.

WARNING

WHENEVER IT APPEARS LIKELY THAT SAFETY PROTECTIVE PROVISIONS HAVE BEEN IMPAIRED, THE APPARATUS SHALL BE MADE INOPERATIVE AND BE SECURED AGAINST ANY UNINTENDED OPERATION. THE PROTECTION IS LIKELY TO BE COMPROMISED IF, FOR EXAMPLE:

-- THE APPARATUS SHOWS VISIBLE DAMAGE.
-- THE INSTRUMENT FAILS TO PERFORM THE INTENDED MEASUREMENT.
-- THE UNIT HAS UNDERGONE PROLONGED STORAGE UNDER UNFAVORABLE CONDITIONS.
-- THE INSTRUMENT HAS SUFFERED SEVERE TRANSPORT STRESS.

8-77. The following five checks are recommended to verify the product safety of the 4271B 1MHz Digital LCR Meter (these check may also be done to check for product safety after troubleshooting and repair). When such checks are needed, perform the following:

1. Visually inspect interior of instrument for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and remedy cause of any such condition.

2. Using a suitable ohmmeter, check resistance from instrument enclosure to ground pin on power cord plug. The reading must be less than 0.5 ohm. Flex the power cord while making this measurement to determine whether intermittent discontinuities exist.

3. Check GUARD terminal on front panel using procedure (2).

4. Disconnect instrument from power source. Turn power switch to on. Check resistance from instrument enclosure to line and neutral (tied together). The minimum acceptable resistance is two megohms. Replace any component which fails or causes a failure.

5. Check line fuse to verify that a correctly rated fuse is installed.

8-78. GENERAL NOTES.

a. Unless otherwise indicated, resistance is in ohms, capacitance in microfarad and inductance in microhenries.

b. Components assigned an asterisk(*) are factory selected with average values shown.

c. The components mounted on chassis or mainframe parts are not assigned an assembly designation (e.g. R1, Q1, etc.).

d. Reference designations (R1, Q1, etc.) within assembly (A1, A2...etc.) use assembly designation as prefix to form complete designation (e.g. R1, in A1 assembly is A1R1).

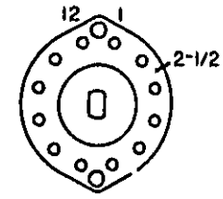
8-79. Additional notes are shown in Figure 8-34.

SYMBOLS

- FRONT PANEL
- REAR PANEL
- KNOB CONTROL
- SCREWDRIVER ADJUST
- MAIN SIGNAL PATH
- FEEDBACK PATH
- CONDUCTING ELEMENT
- CW — WIPER MOVES TOWARD "CW" WHEN CONTROL IS ROTATED CLOCKWISE
- FLOATABLE CIRCUIT COMMON
- ASSEMBLY CIRCUIT COMMON
- CHASSIS CIRCUIT COMMON
- TP — TEST POINT
- "AND" GATE
- "NOR" GATE
- "OR" GATE
- INVERTER
- "NAND" GATE
- INVERTER

SWITCH DESIGNATIONS

A351BR(2-1/2)



A3S1	SWITCH S1 WITHIN ASSEMBLY A3
B	2ND WAFER FROM FRONT (A=1ST, ETC)
R	REAR OF WAFER (F=FRONT)
(2-1/2)	TERMINAL LOCATION (2½) (VIEWED FROM FRONT)

REFERENCE DESIGNATIONS

REFERENCE DESIGNATIONS WITHIN ASSEMBLIES ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.

ASSEMBLY	ABBREVIATION	COMPLETE DESCRIPTION
A25	C1	A25C1
A25A1	CR1	A25A1CR1
NO PREFIX	J3	J3

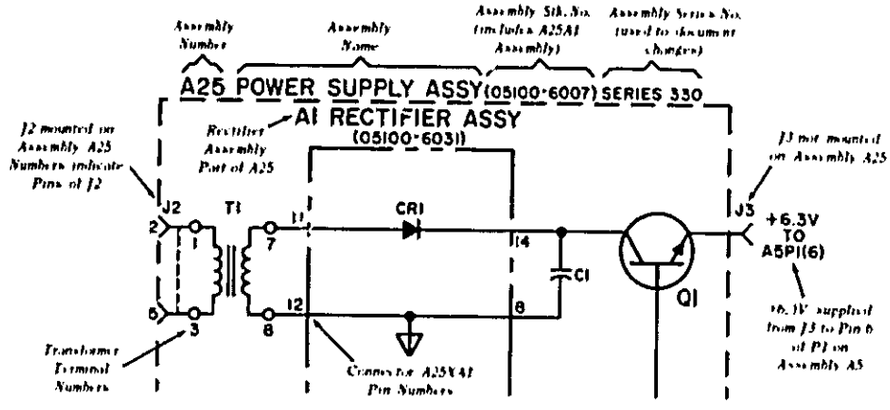


Figure 8-34. Schematic Diagram Notes

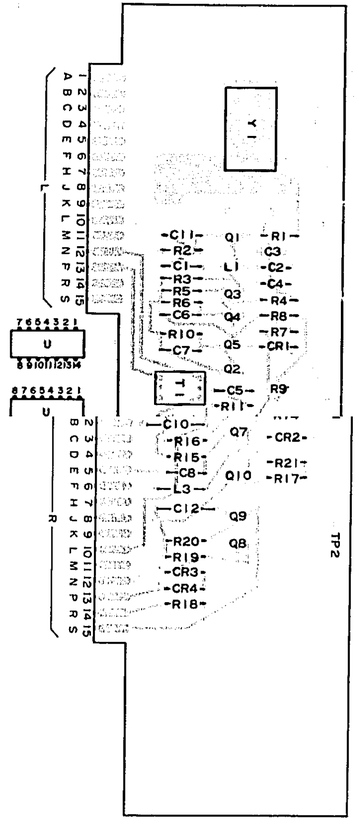


Figure 8-45. A4 Oscillator Board Assembly Component Locations.

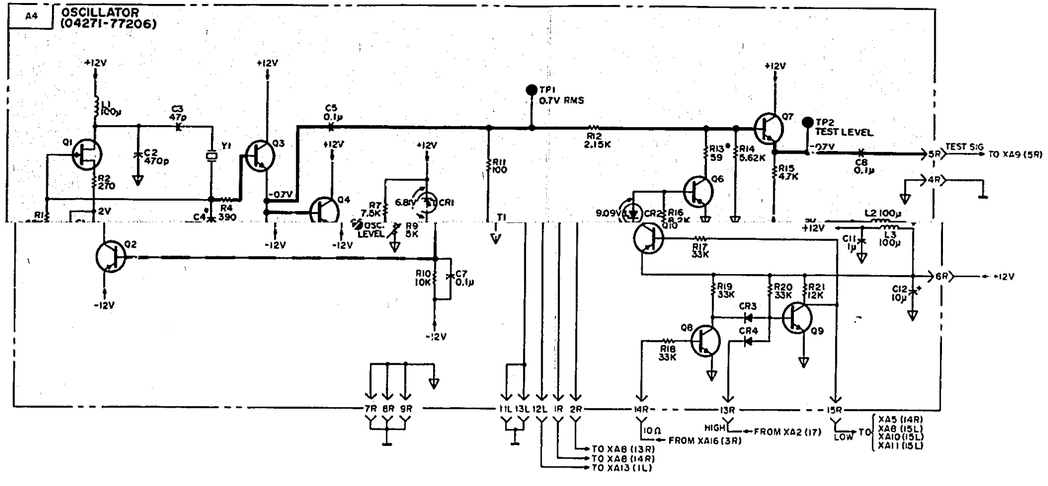


Figure 8-46. A4 Oscillator Board Assembly Schematic Diagram.

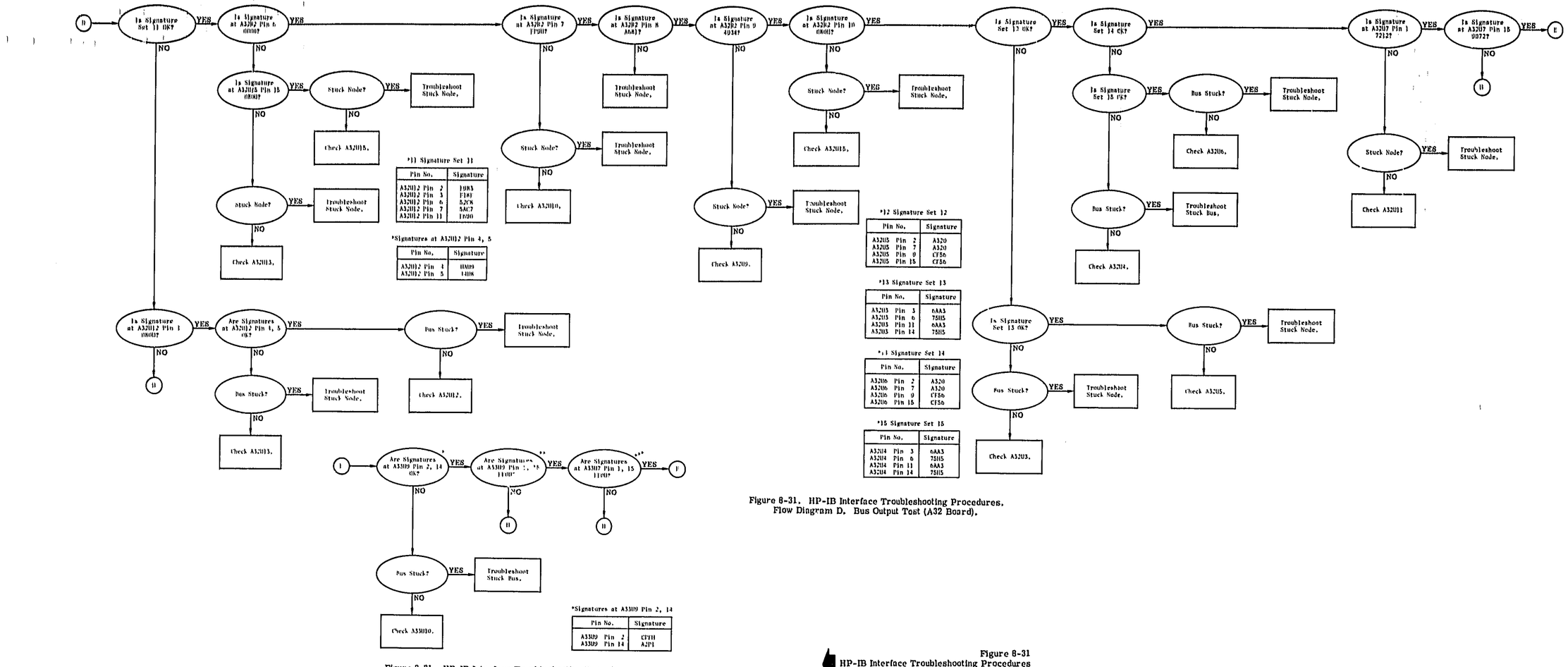
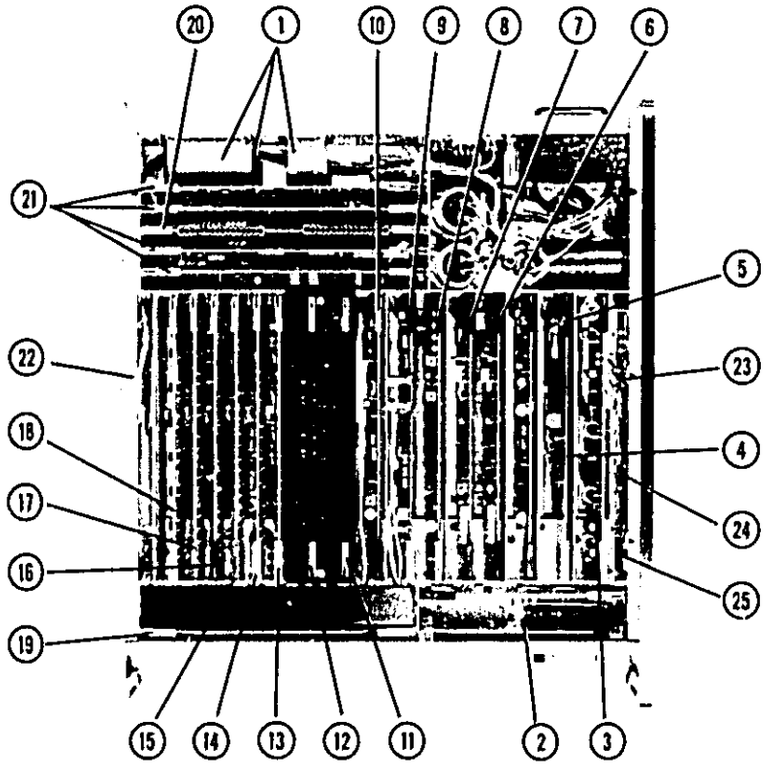


Figure 8-31. HP-IB Interface Troubleshooting Procedures. Flow Diagram D. Bus Output Test (A32 Board).

Figure 8-31. HP-IB Interface Troubleshooting Procedures. Flow Diagram E. Bus Output Test (A33 Board).

SEE INSIDE

Figure 8-31
HP-IB Interface Troubleshooting Procedures
Flow Diagram C



1. Connection Boards.
2. A2 Board Assembly.
3. A3 Board Assembly.
4. A4 Board Assembly.
5. A5 Board Assembly.
6. A6 Board Assembly.
7. A7 Board Assembly.
8. A8 Board Assembly.
9. A9 Board Assembly.
10. A10 Board Assembly.
11. A11 Board Assembly.
12. A12 Board Assembly.
13. A13 Board Assembly.
14. A14 Board Assembly.
15. A15 Board Assembly.
16. A16 Board Assembly.
17. A17 Board Assembly.
18. A18 Board Assembly.
19. A19 Board Assembly.
20. Extender Board.
21. Option Boards.
22. Transistor Q3.
23. Transistor Q2.
24. Transistor CR5.
25. Transistor Q1.

Figure 8-35. Assembly and Component Locations: Top View.

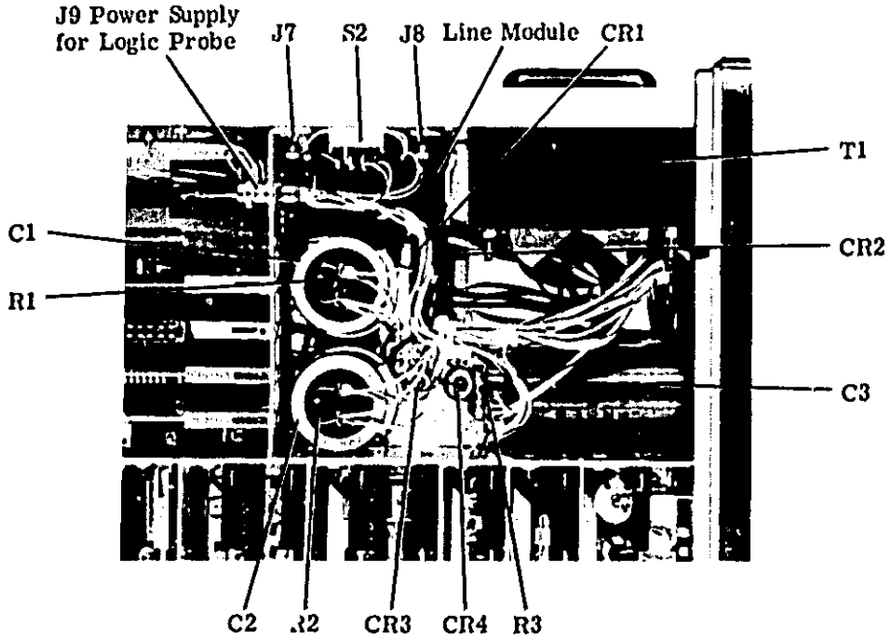


Figure 8-36. Component Locations: Power Supply Section.

A2 Troubleshooting

Most A2 troubles can be found by Front Panel operation. A2S1 (RANGE) and A2S3 (FUNCTION) can be checked by referring to Table 3-4 on page 3-6. A2S4 (TEST SIG LEVEL) is checked by monitoring oscillating level at A4TP2. If trouble is not located by above procedures, check A2S2 (TRIGGER) and A2R1 (RATE).

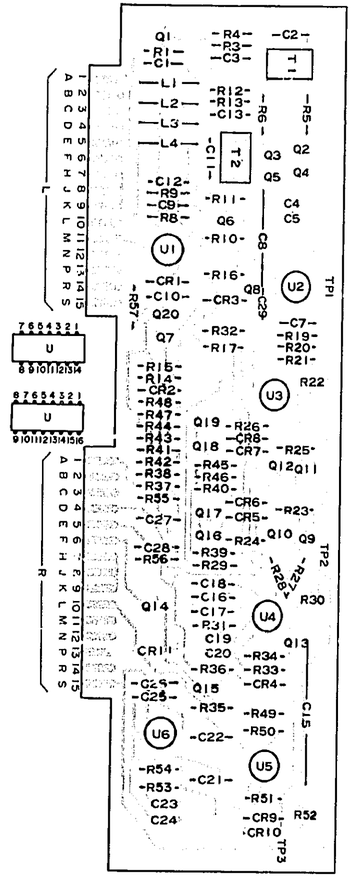


Figure 8-57. A7 G/R Synchronous Detector & Integrator Board Assembly Component Locations.

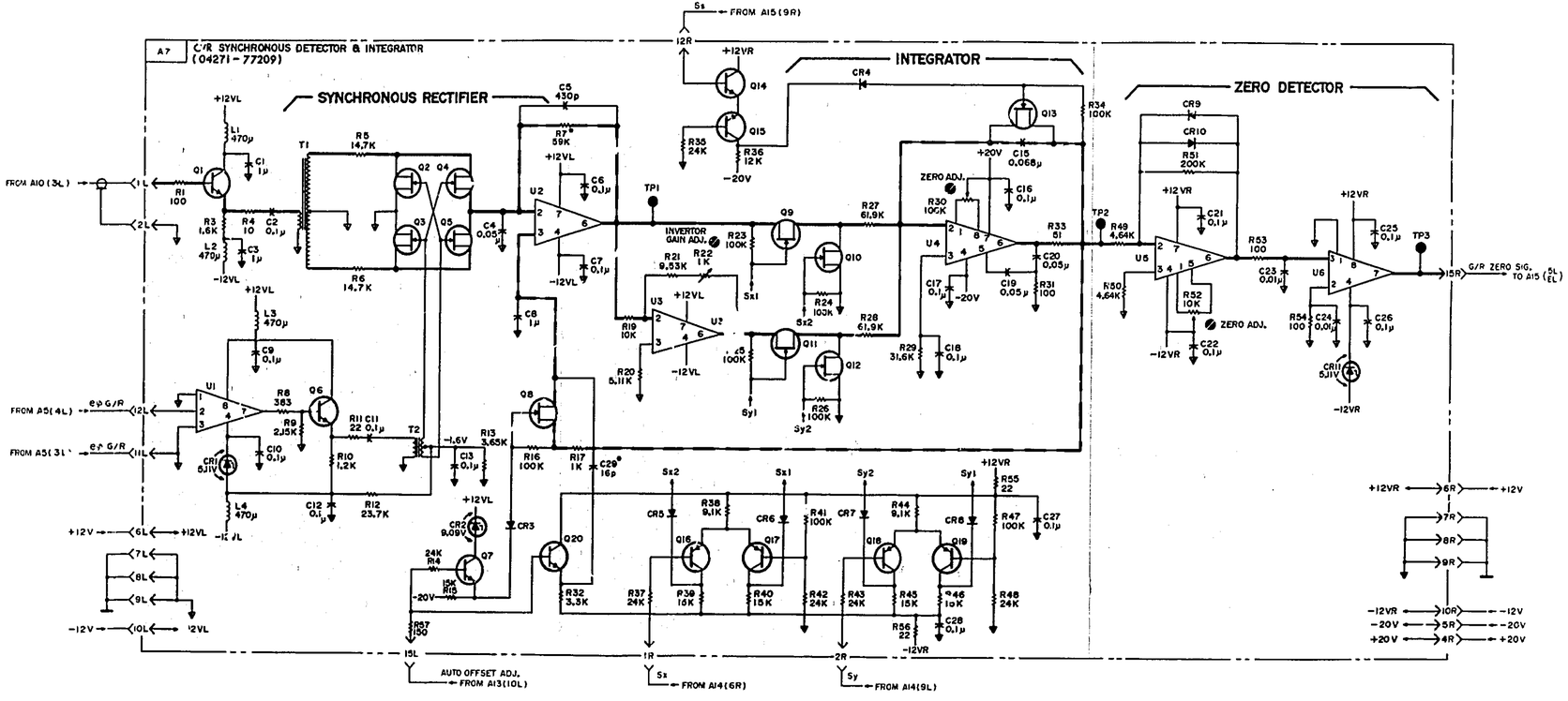


Figure 8-58. A7 G/R Synchronous Detector & Integrator Board Assembly Schematic Diagram.

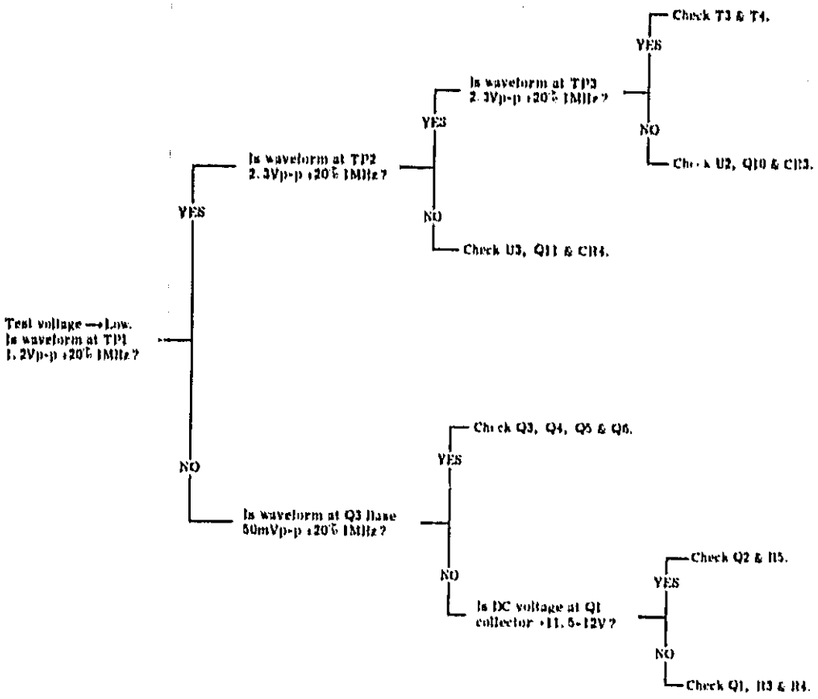


Figure 8-47. A6 Reference Phase Generator Board Troubleshooting Tree.

A5 BOARD CIRCUIT DESCRIPTION

Refer to Figure 8-48 for block diagram of A5 Reference Phase Generator. At the Phase Shifter U2 and U3, the signals for phase detecting $e_{\phi G/R}$ and $e_{\phi C/L}$ are generated and are transmitted to A6/A7 Integrators. If a Low signal comes, Q1 and Q2 are turned off and the input signal is amplified 25 times. In the low signal does not come, Q1 and Q2 are turned on and the input signal is amplified 1 time.

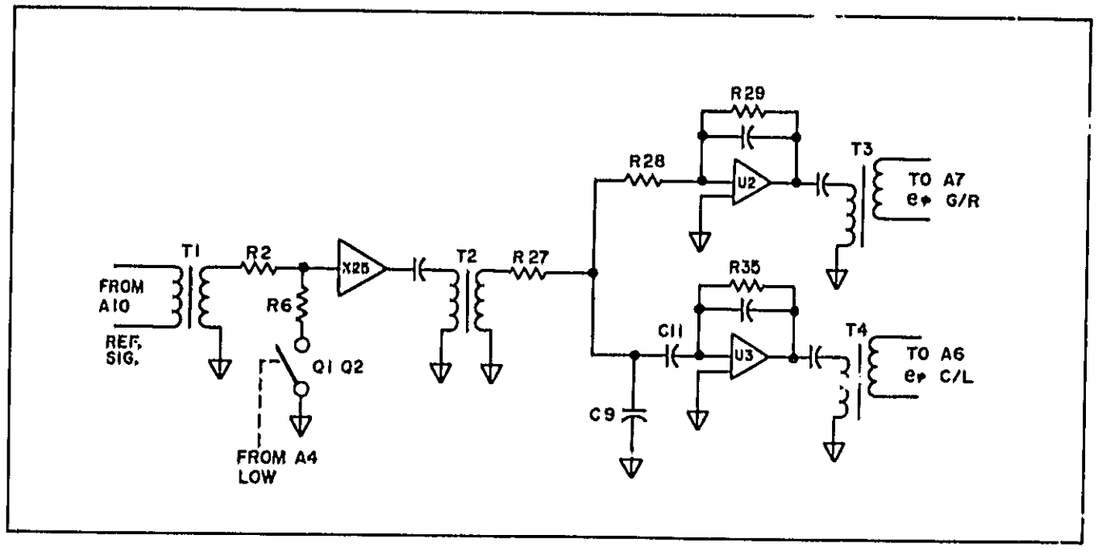


Figure 8-48. Block Diagram of A5 Board.

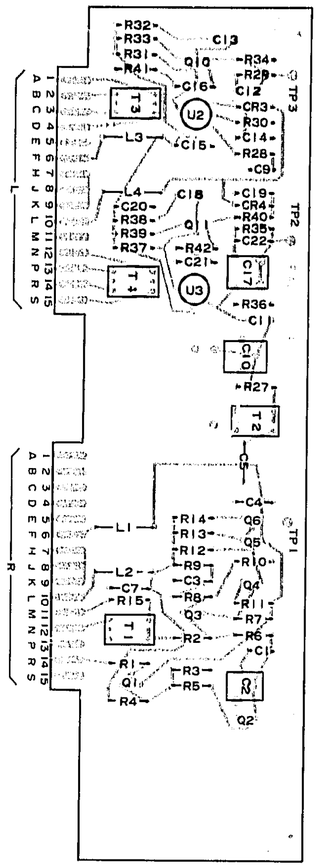


Figure 8-49. A5 Reference Phase Generator Board Assembly Component Locations.

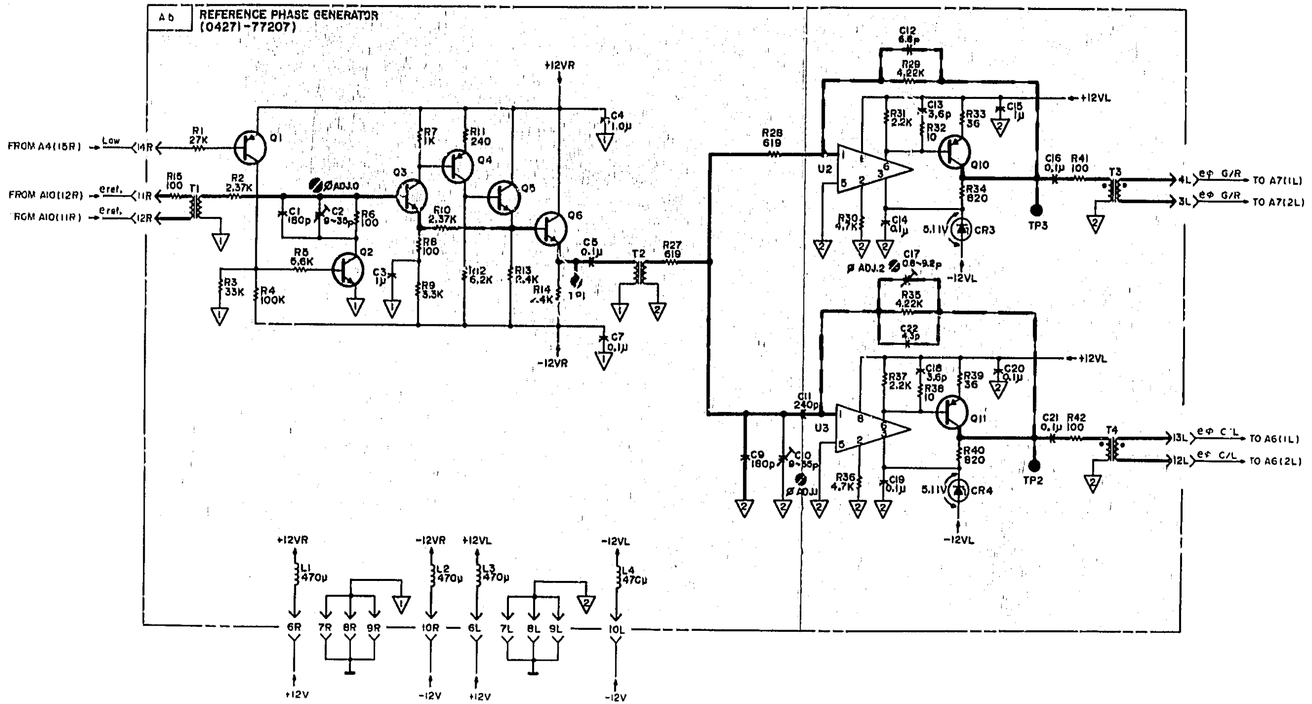


Figure 8-50. A5 Reference Phase Generator Board Assembly Schema ic Diagram.

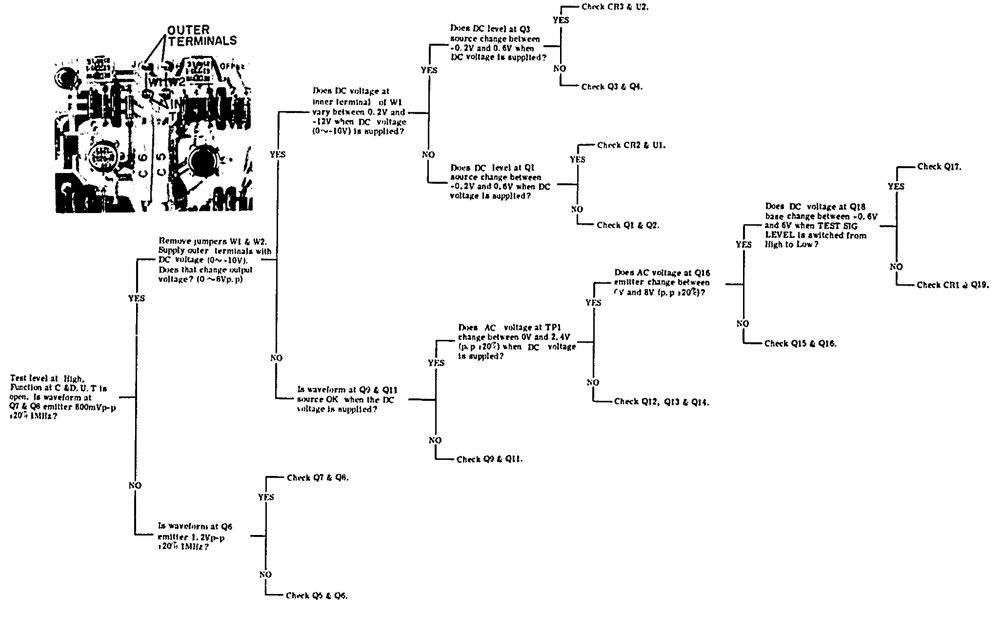


Figure 8-59. A8 Modulator Board Troubleshooting Tree.

A8 BOARD CIRCUIT DESCRIPTION

Figure 8-60 is the block diagram of A8 Modulator. The null out signal from A11 Current Detector is divided into their real parts and imaginary parts by the $\phi_{C/L}$ signal and $\phi_{G/R}$ signal and are transmitted to the Modulator. Two signals, one phase synchronized with the reference signal and one 90° phase shifted, are generated prior to modulating. The signal which has same phase is modulated with the real part; the signal which has a 90° shifted phase is modulated with the imaginary part. These modulated signals are summed by the Summing Amplifier. The summed signal is filtered by the Tuned Amplifier to remove the third harmonic and transmitted to A9 Power Amplifier through Emitter Follower Q17.

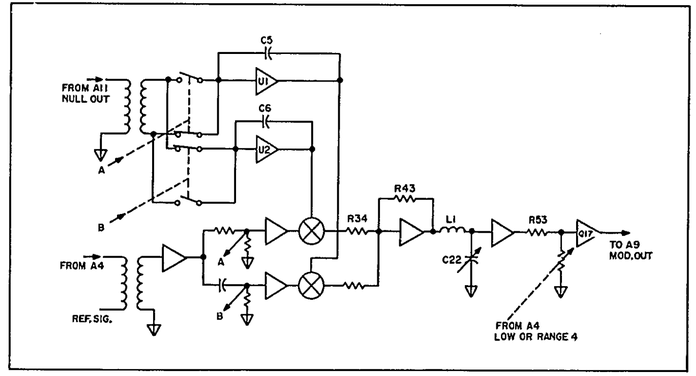


Figure 8-60. Block Diagram of A8 Board.

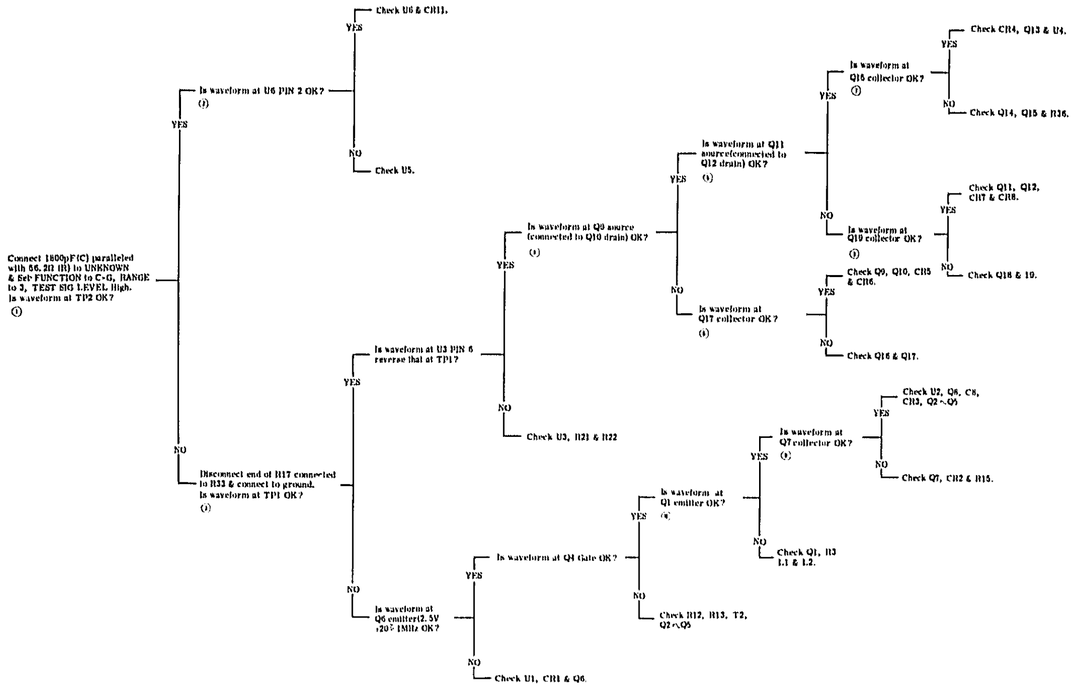
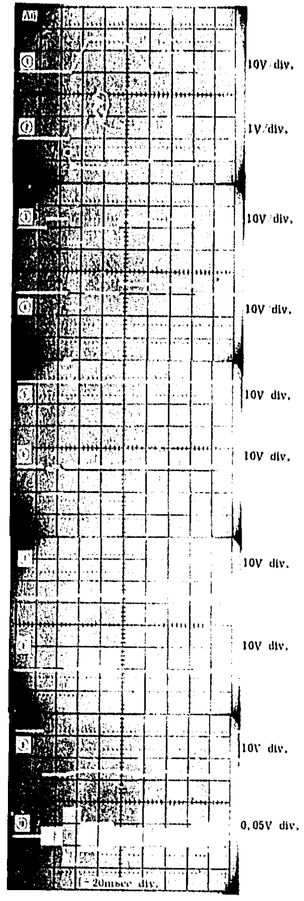


Figure 8-51. A6 C/L Synchronous Detector & Integrator Board Troubleshooting Tree.



A5 Reference Phase Generator SERVICE SHEET 5
SEE INSIDE

A6 BOARD CIRCUIT DESCRIPTION

Figure 8-52 is the block diagram of the A6 C/L Integrator. The output signal from A10 Buffer Ampl. and C8, G8 Ampl. is phase detected by the $e_{\phi C/L}$ ($e_{\phi G/R}$) signal which is generated in the A5 Reference Phase Generator. Charging and discharging of capacitor C16 is done by operating the switches with Sx, Sy from A14 Gate/Transfer Pulse Control. The output of the integrator is compared to zero volts by the zero level detector. When the output of the integrator becomes zero, a zero detect signal is transmitted to A15 Step Control. The switch Q13 for discharging C16 is controlled by S_S from A15 (see paragraph 8-29). An auto offset adjustment is performed to remove the offset voltage of U2 and phase detector by Q8 and C8.

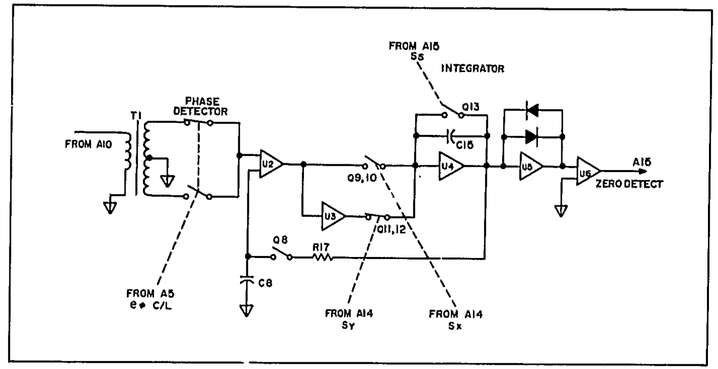


Figure 8-52. Block Diagram of A6 Board.

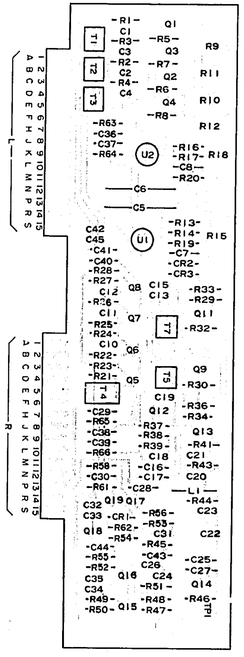


Figure 8-61. A8 Modulator Board Assembly Component Locations.

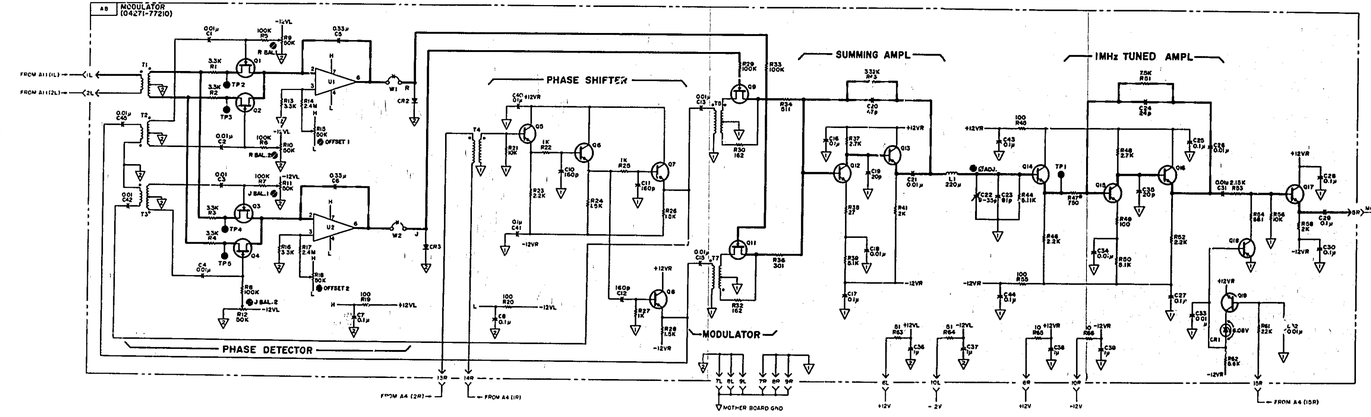


Figure 8-62. A8 Modulator Board Assembly Schematic Diagram.

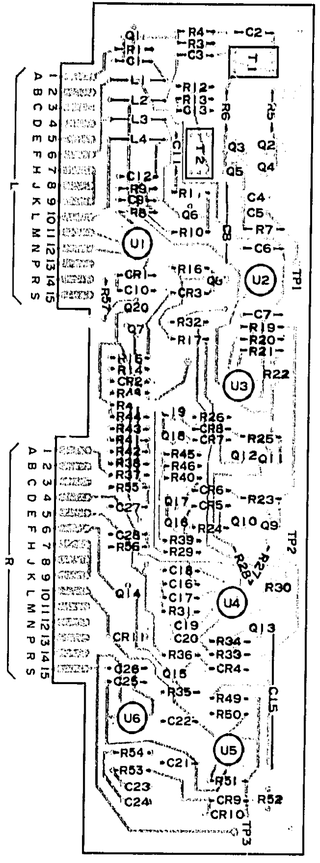


Figure 8-53. A6 C/L Synchronous Detector & Integrator Board Assembly Component Locations.

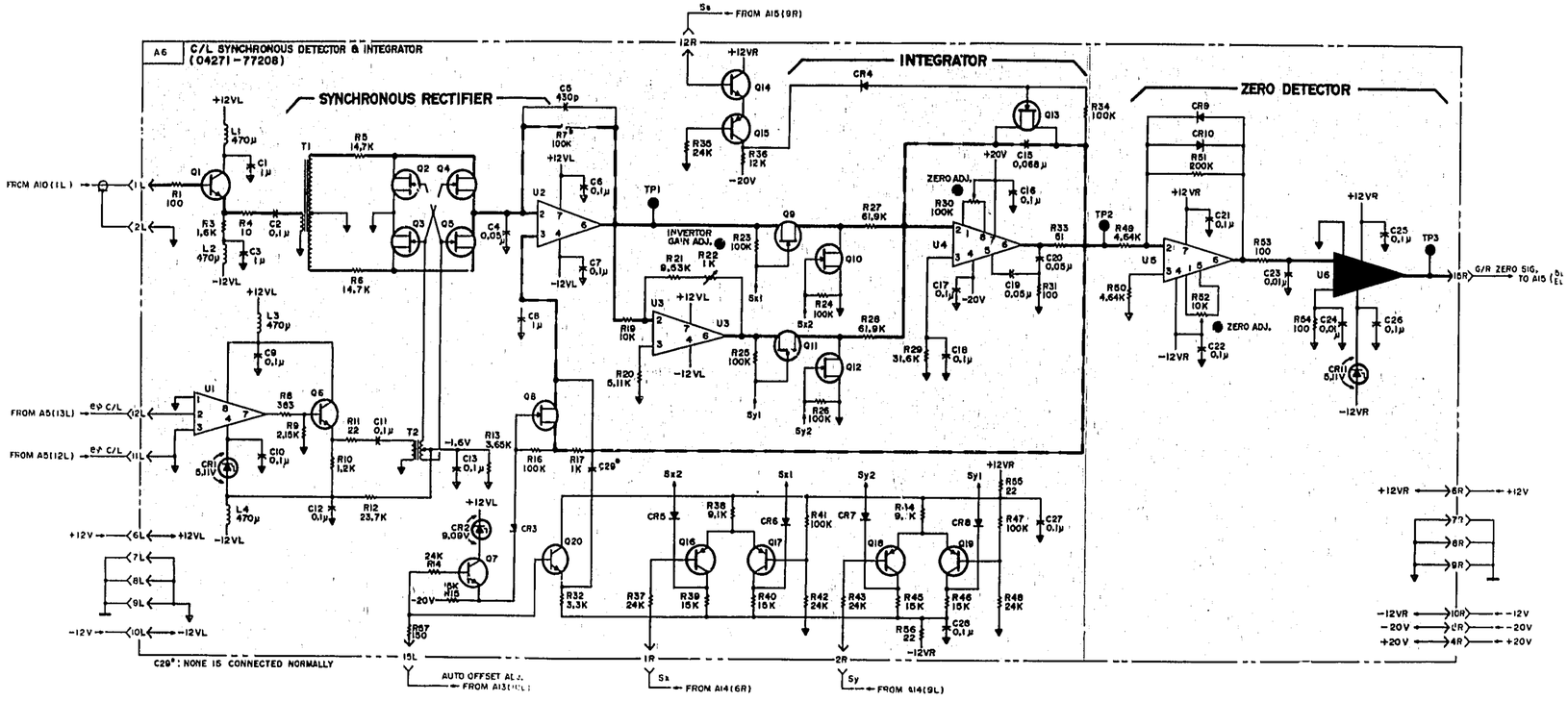


Figure 8-54. A6 C/L Synchronous Detector & Integrator Board Assembly Schematic Diagram.

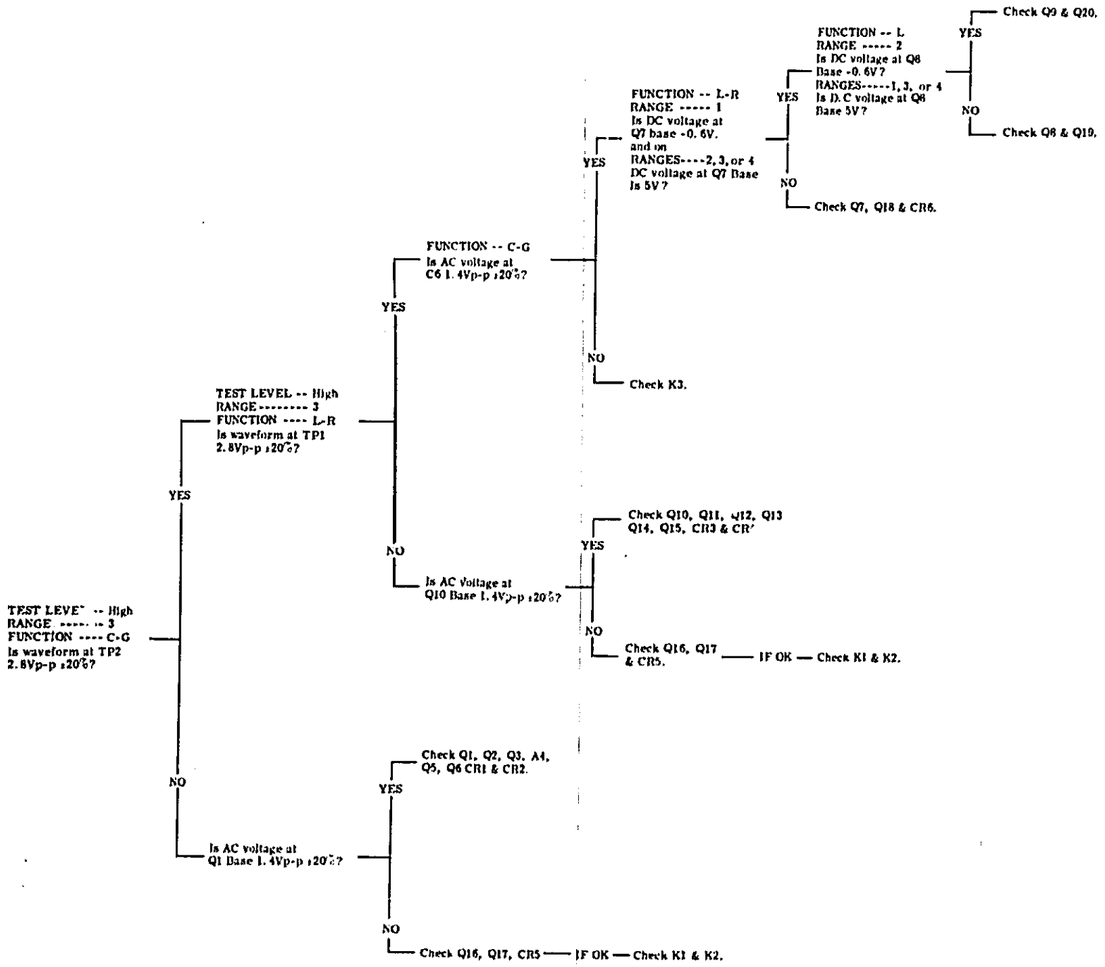


Figure 8-63. A9 Power Amplifier Board Troubleshooting Tree.

A9 BOARD CIRCUIT DESCRIPTION

Figure 8-64 is the block diagram of A9 Power Amplifier. The output signals from A4 Osc and A8 Modulator are amplified. When FUNCTION is set to C, switches K1, K2 and K3 are as shown in Figure 8-64. If FUNCTION is set to L, all switches are reversed. The test signals from A4 and modulated output from A8 are amplified. One is transmitted to A12 Reference Resistor through T_1. The other is transmitted through a resistor and T_2 to remove noise when the function is set to L. The signal for offset adjustment is transmitted through J2. The signal to the front panel connector is transmitted through J3. This assembly also contains the circuit for DC bias.

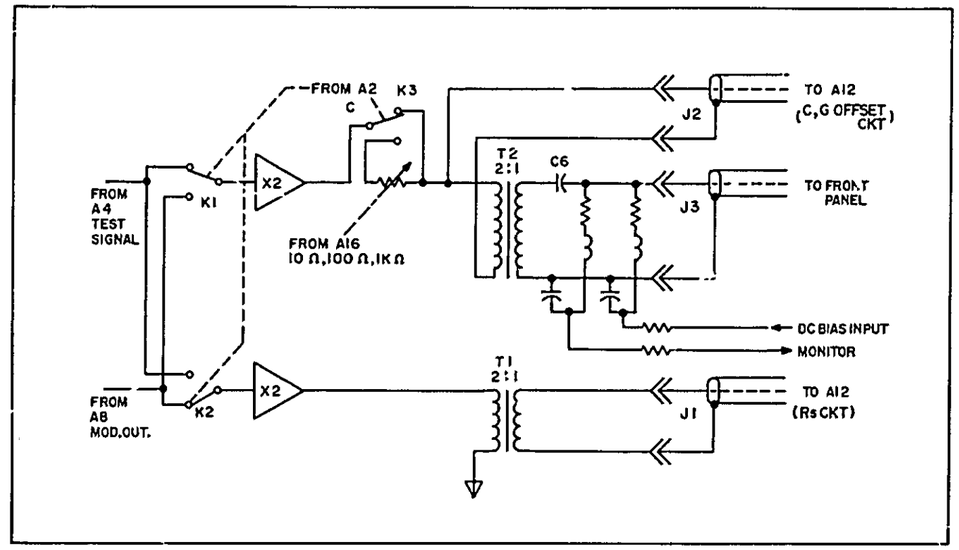


Figure 8-64. Block Diagram of A9 Board.

A8 Modulator SERVICE SHEET 8
SEE INSIDE

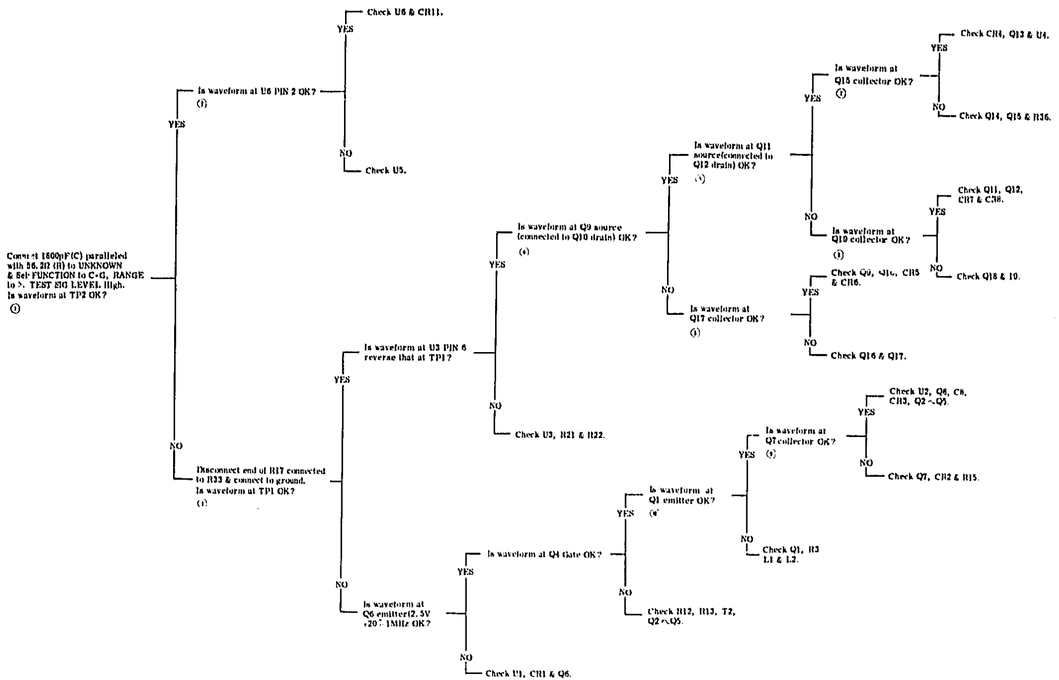
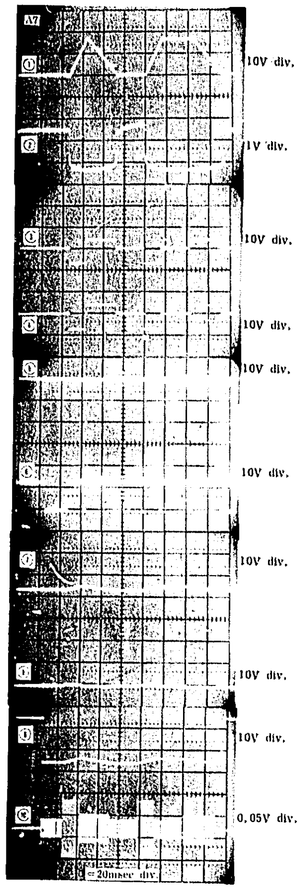


Figure 8-55. A7 G/R Synchronous Detector & Integrator Board Troubleshooting Tree.



A7 BOARD CIRCUIT DESCRIPTION

Figure 8-56 is the block diagram of the A7 G/R Integrator. The output signal from A10 Buffer Ampl, and C_S, G_S Ampl, is phase detected by the $\phi_{C/L}$ ($\phi_{G/R}$) signal which is generated in the A5 Reference Phase Generator. Charging and discharging of capacitor C15 is done by operating the switches with Sx, Sy from A14 Gate/Transfer Pulse Control. The output of the integrator is compared to zero volts by the zero level detector. When the output of the integrator becomes zero, a zero detect signal is transmitted to A15 Stop Control. The switch Q13 for discharging C15 is controlled by S_S from A15 (see paragraph 8-29). An auto offset adjustment is performed to remove the offset voltage of U2 and phase detector by Q8 and C8.

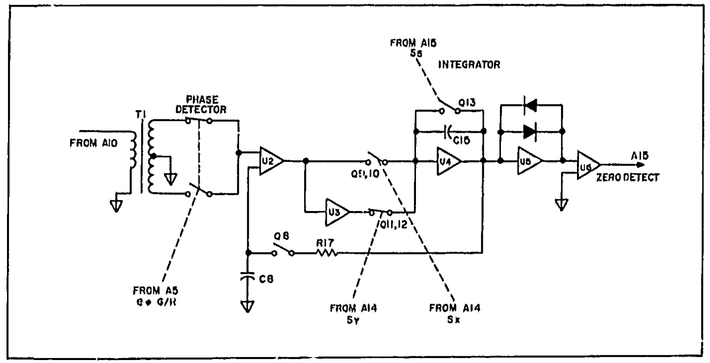


Figure 8-56. Bolock Diagram of A7 Board.

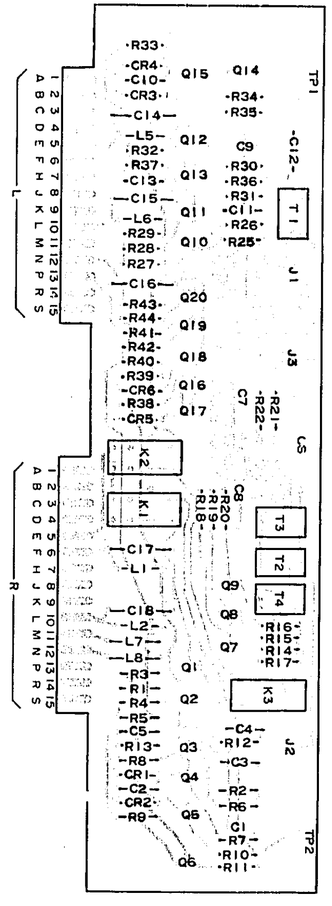


Figure 8-65. A9 Power Amplifier Board Assembly Component Locations.

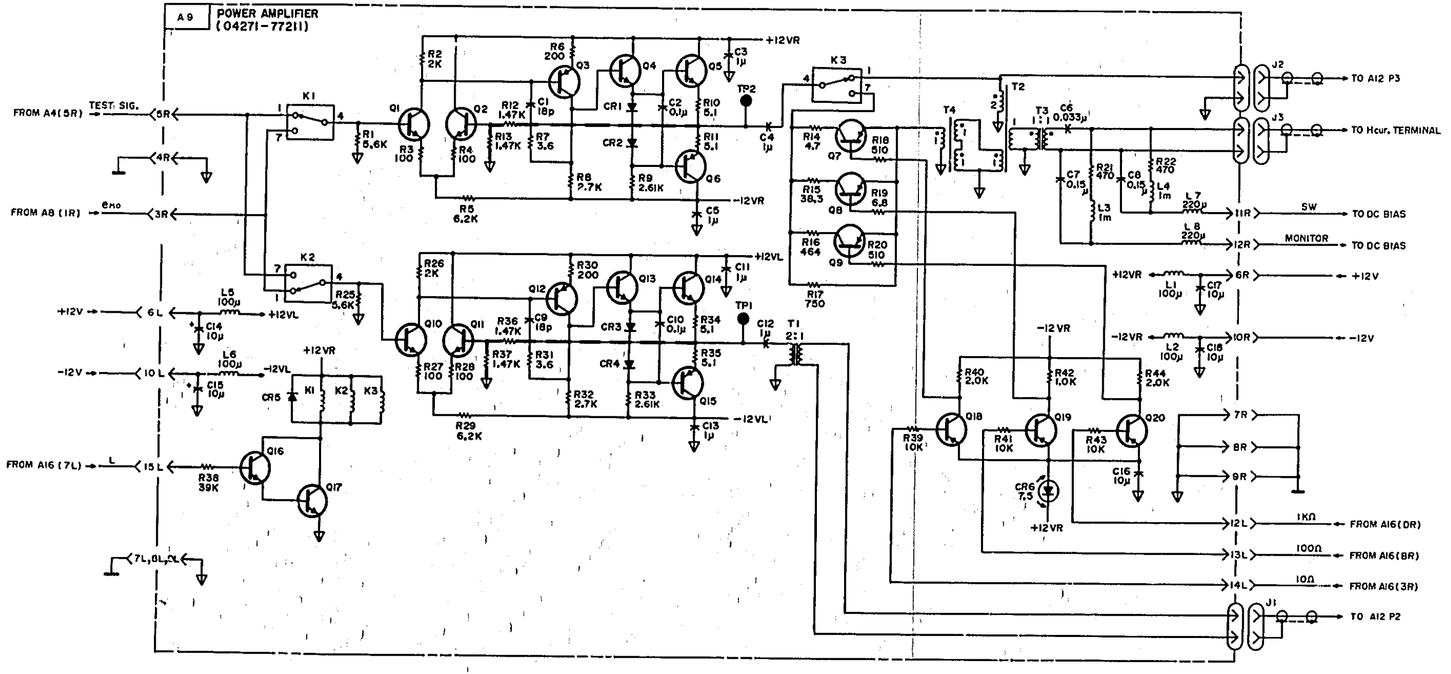


Figure 8-66. A9 Power Amplifier Board Assembly Schematic Diagram.

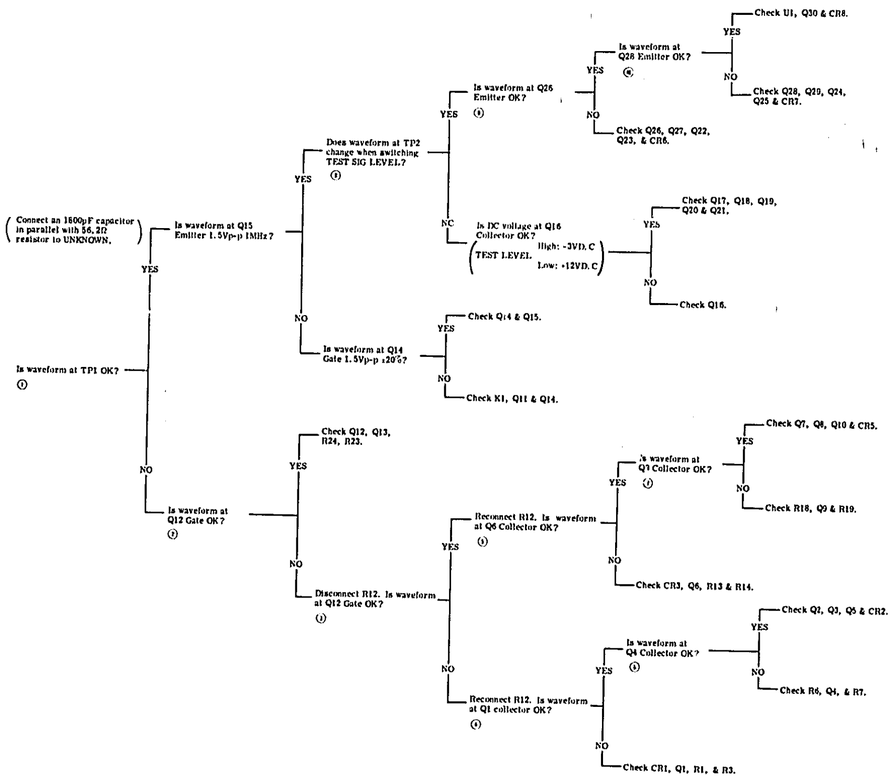
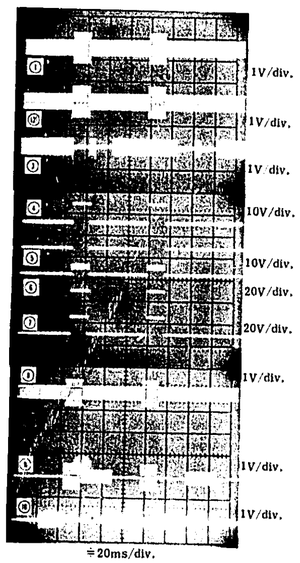


Figure 8-67. A10 Buffer & Cs, Gs Amplifier Board Troubleshooting Tree.



A10 BOARD CIRCUIT DESCRIPTION

Figure 8-68 is the block diagram of A10 Buffer Ampl. and C_S, G_S Ampl. During a C measurement time, a reference signal, and during L measurement time, the unknown signal are transmitted form "HPOT" connector on the front panel through J2. During a C measurement time, an unknown signal and during a L measurement time, a reference signal is transmitted from A12 Reference Resistor through J3. The S_D and S_R signals from A15 determine whether a reference signal or an unknown signal is fed to A6 & A7 Integrators. After amplification, these signals are transmitted to G_S/C_S Amplifier through T_5. Since the G_S/C_S Amplifier signal passes through T_6, it is changed in amplitude and phase. In this manner, C/L and G/R become measurable. See paragraph 8-29 TIMING DIAGRAM DISCUSSION.

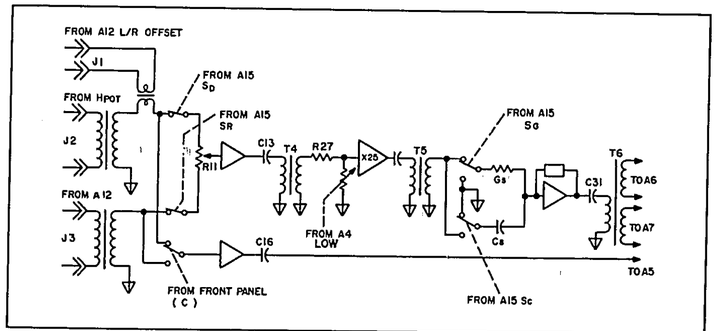


Figure 8-68. Block Diagram of A10 Board.

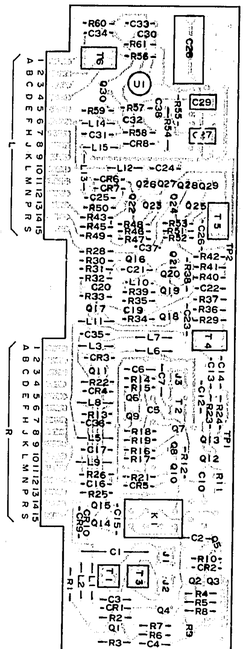


Figure 8-69. A10 Buffer & Cs, Gs Amplifier Board Assembly Component Locations.

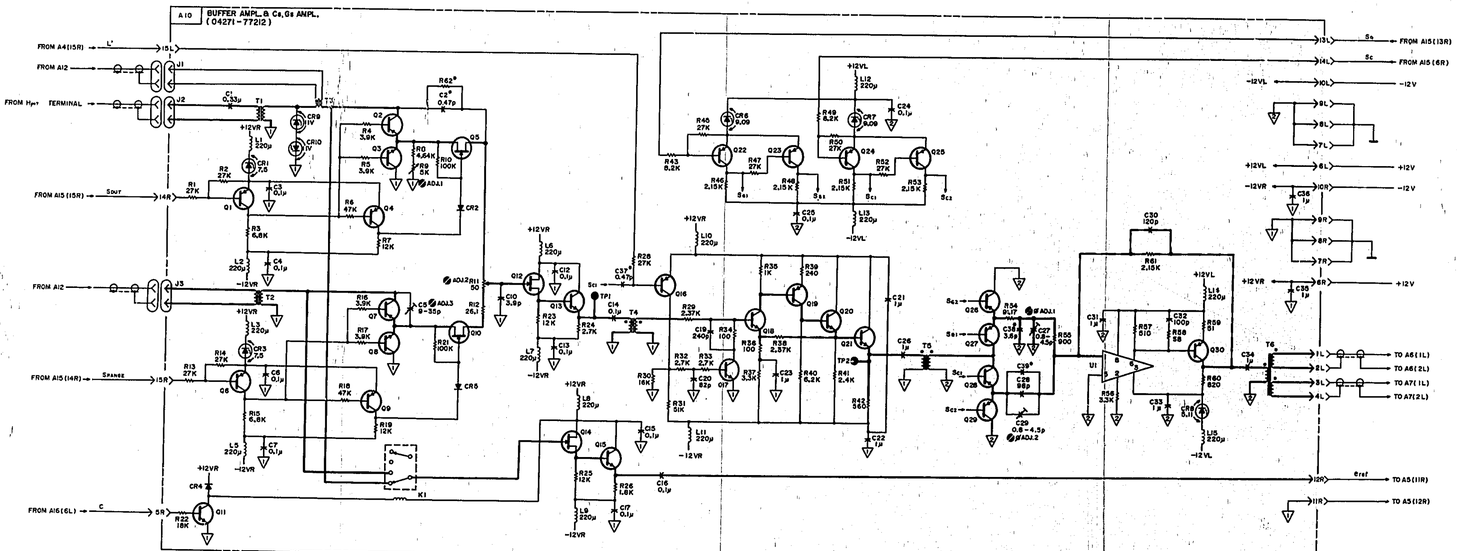


Figure 8-70. A10 Buffer & Cs, Gs Amplifier Board Assembly Schematic Diagram.

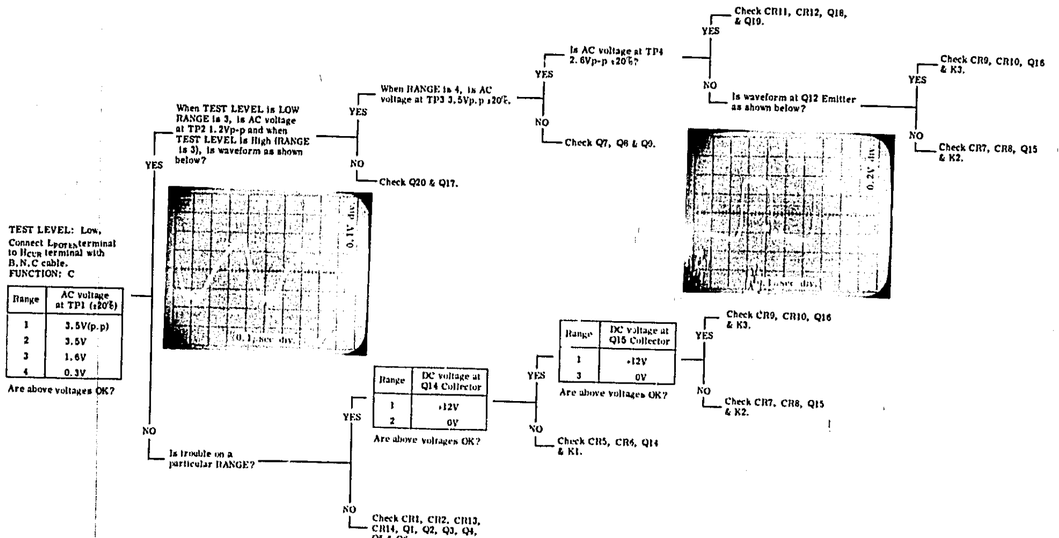


Figure 8-71. A11 Null Detector Board Troubleshooting Tree.

A11 BOARD CIRCUIT DESCRIPTION

Figure 8-72 is a block diagram of the A11 Null Detector. The signal from the "LPOT" connector on Front Panel is fed to Current Detector. The feedback impedance of the Current Detector is varied with the range signal from A16. The output of the Current Detector is attenuated, when the test signal level is set to HIGH, and fed through its amplifier and T2 to the limit amplifier. At the limit amplifier, the signal is changed to a square wave, then back to a sine wave by a tuning filter and fed to the A8 Modulator. When the output voltage is between 150 and 250mV an "UNBAL" signal is fed to A13.

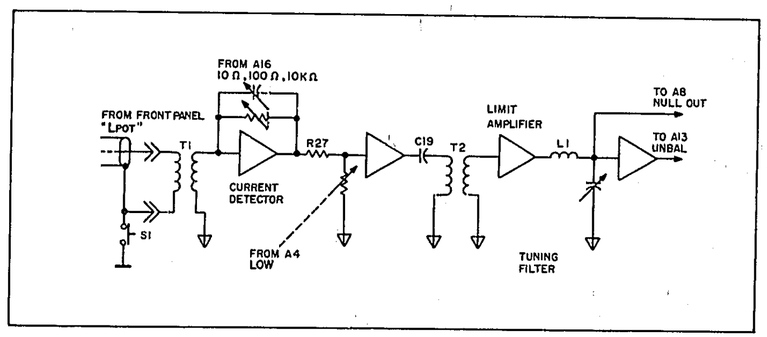


Figure 8-72. Block Diagram of A11 Board.

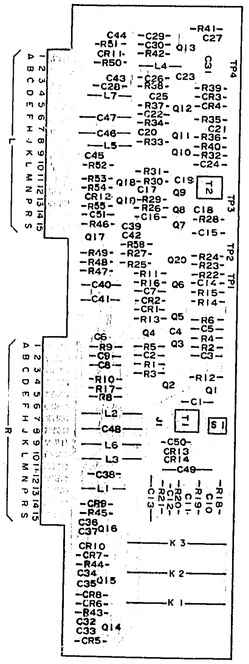


Figure 8-73. A11 Null Detector Board Assembly Component Locations.

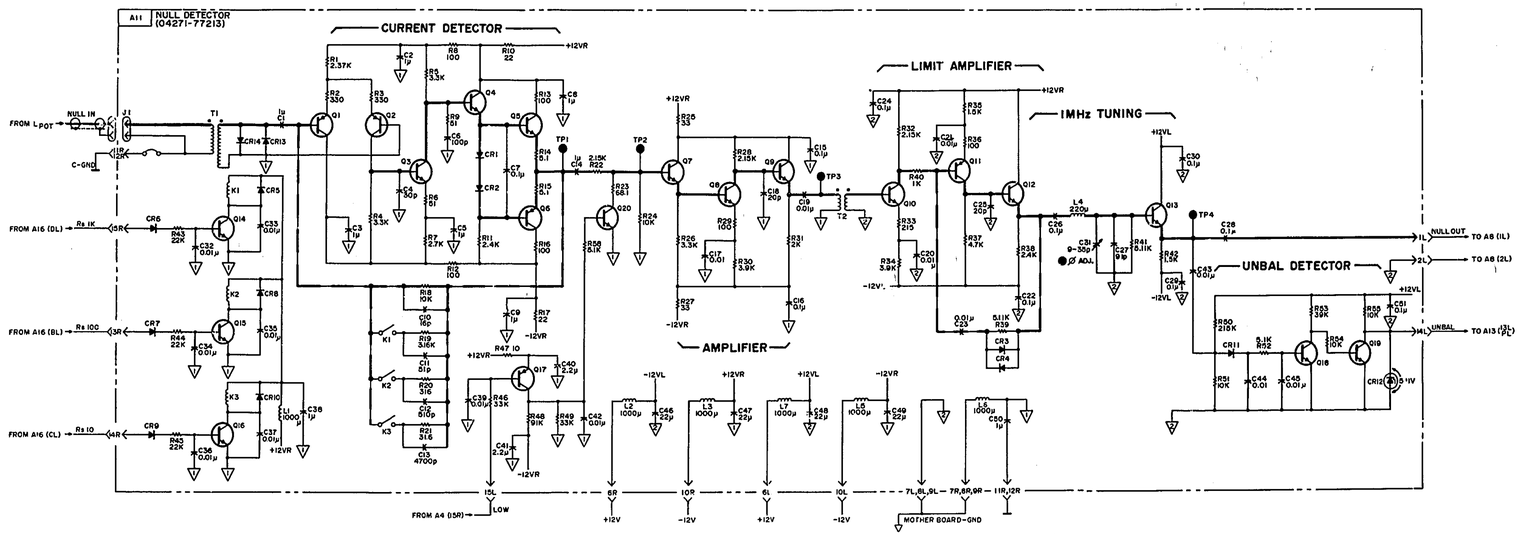


Figure 8-74. A11 Null Detector Board Assembly Schematic Diagram.

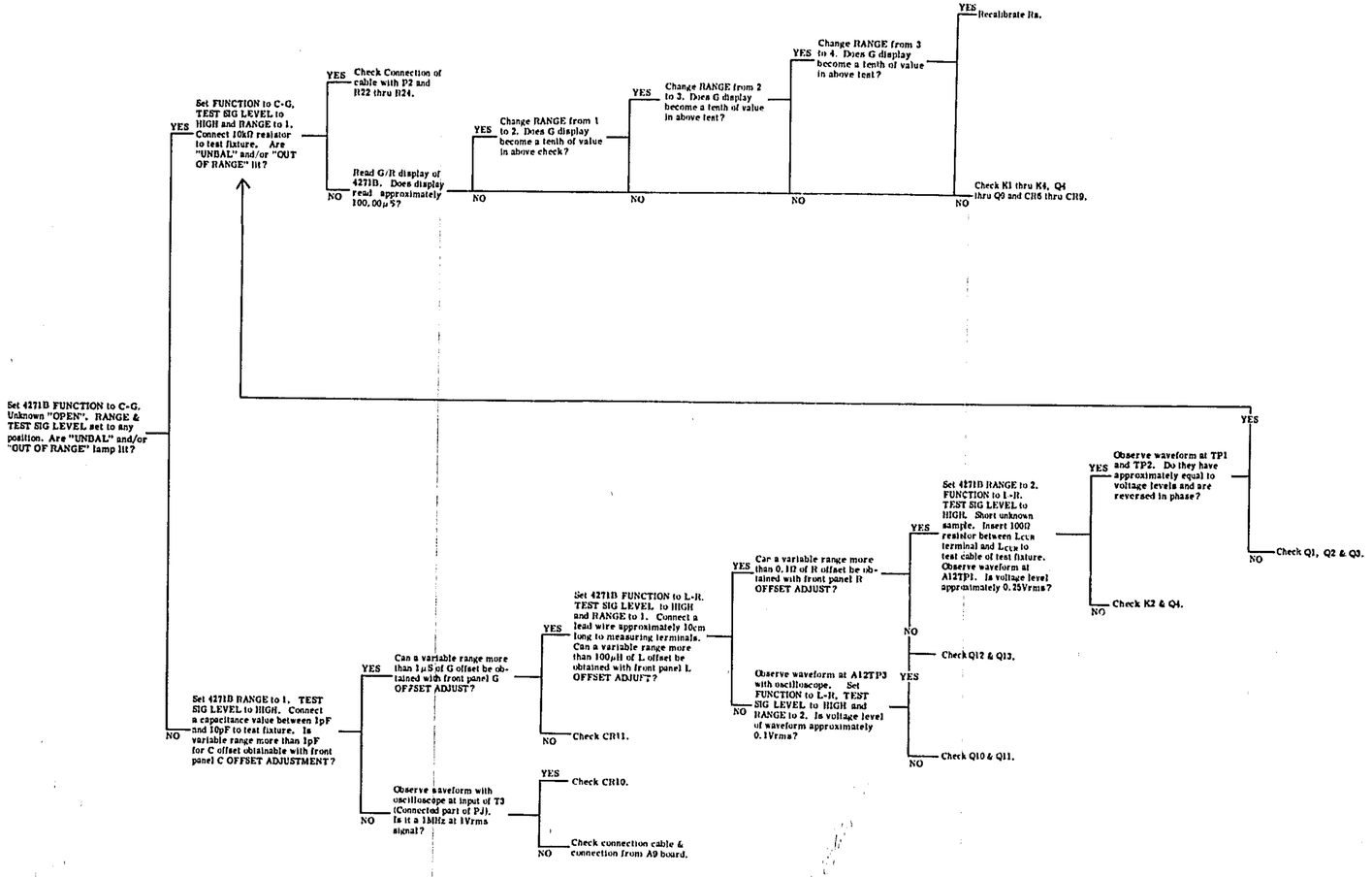


Figure 8-75. A12 Rs & Offset Board Troubleshooting Tree.

A11 Null Detector SERVICE SHEET 11
SEE INSIDE

A12 BOARD CIRCUIT DESCRIPTION

Figure 8-76 is the block diagram of A12 Rs and Offset Circuit. In this board, selection of range resistor and adjustment of offset are accomplished. Range resistors are selected by K1, K3, K4 and Q4 which are controlled with signals from A16 (Range & Function Control). A16 is controlled from the front panel with the RANGE and FUNCTION switches. Q1, Q2, Q3 and T_1 form a circuit which is used to accurately detect exact voltage drop across range resistor. This voltage, which is E_{k1}-E_{k2}, is transmitted to A10 through transformer T_1 and compensates for the voltage drop which is caused by residual resistance or wiring resistance. The Offset Circuit compensates for stray capacitance, residual conductance (when the DUT is a capacitor), residual inductance and residual resistance of DUT. The C/G Offset Circuit compensates for leakage current and produces a reverse current to the leakage current. The L/R Offset Circuit detects the current which flows through DUT and generates a compensating voltage and which is added to voltage from the H_{POT} terminal.

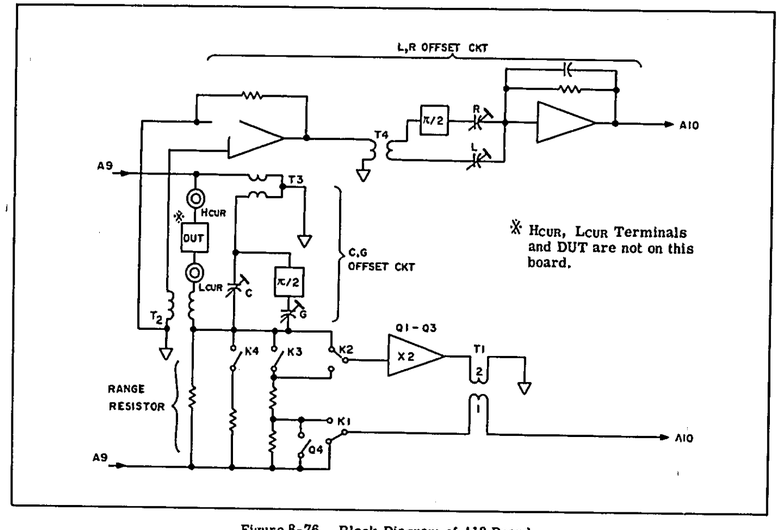


Figure 8-76. Block Diagram of A12 Board.

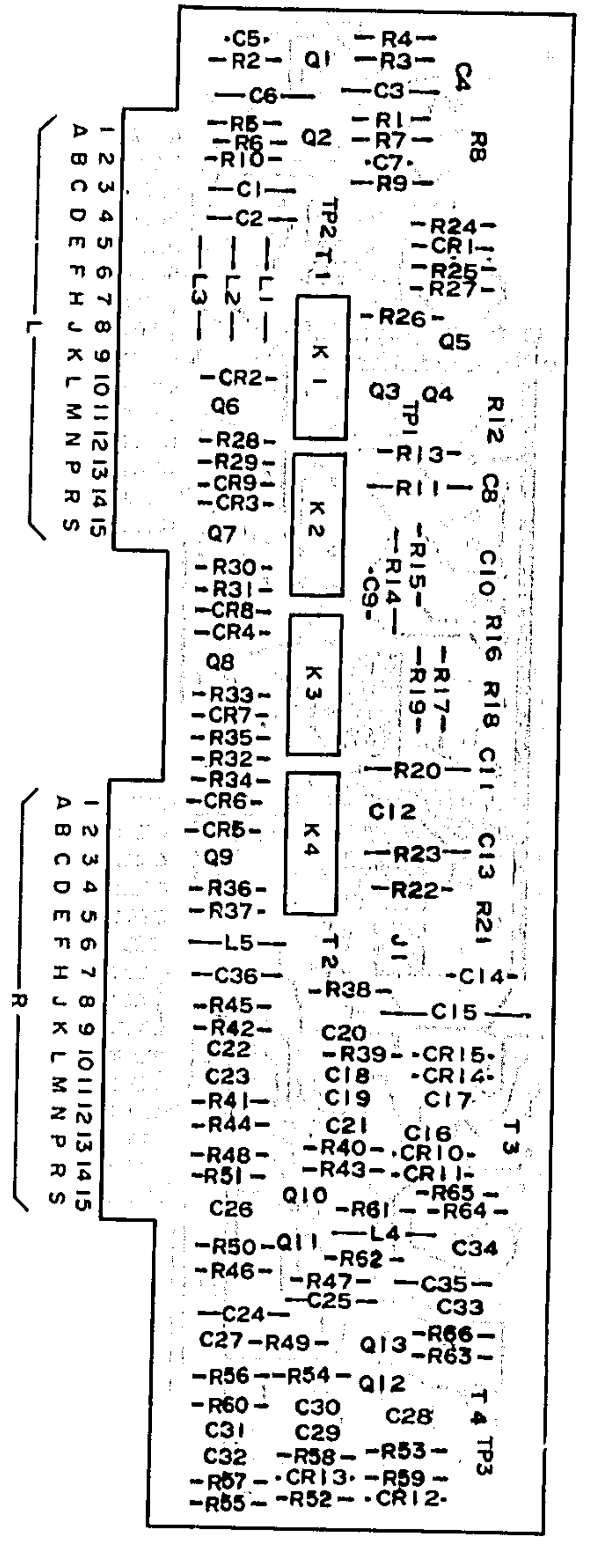


Figure 8-77. A12 Rs & Offset Board Assembly Component Locations.

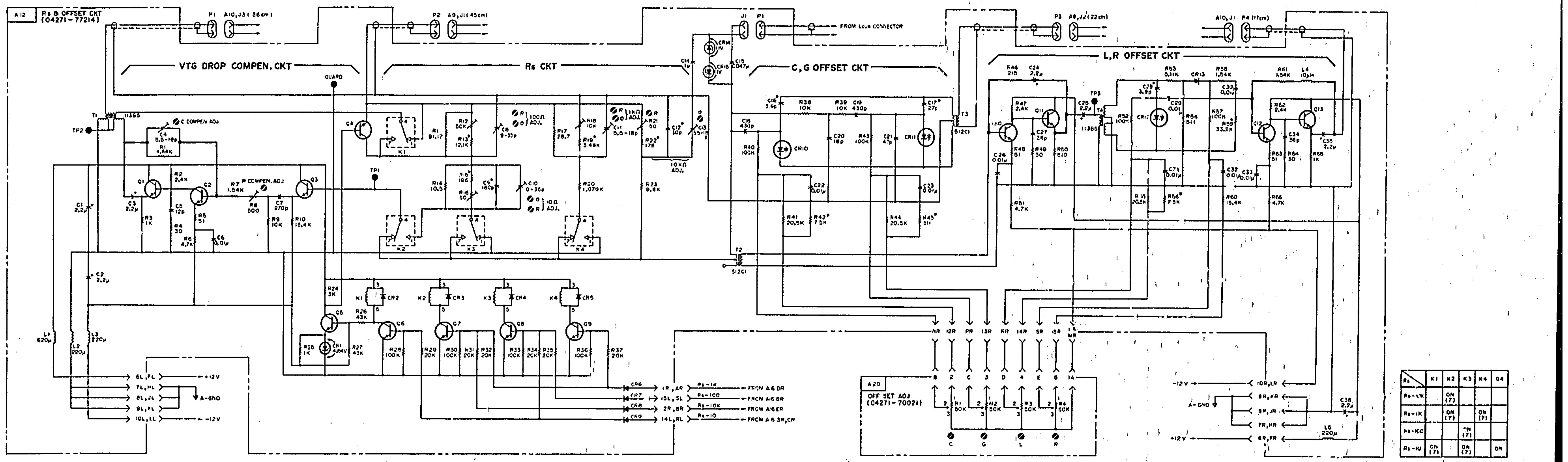


Figure 8-78. A12 Rs & Offset Board Assembly Schematic Diagram.

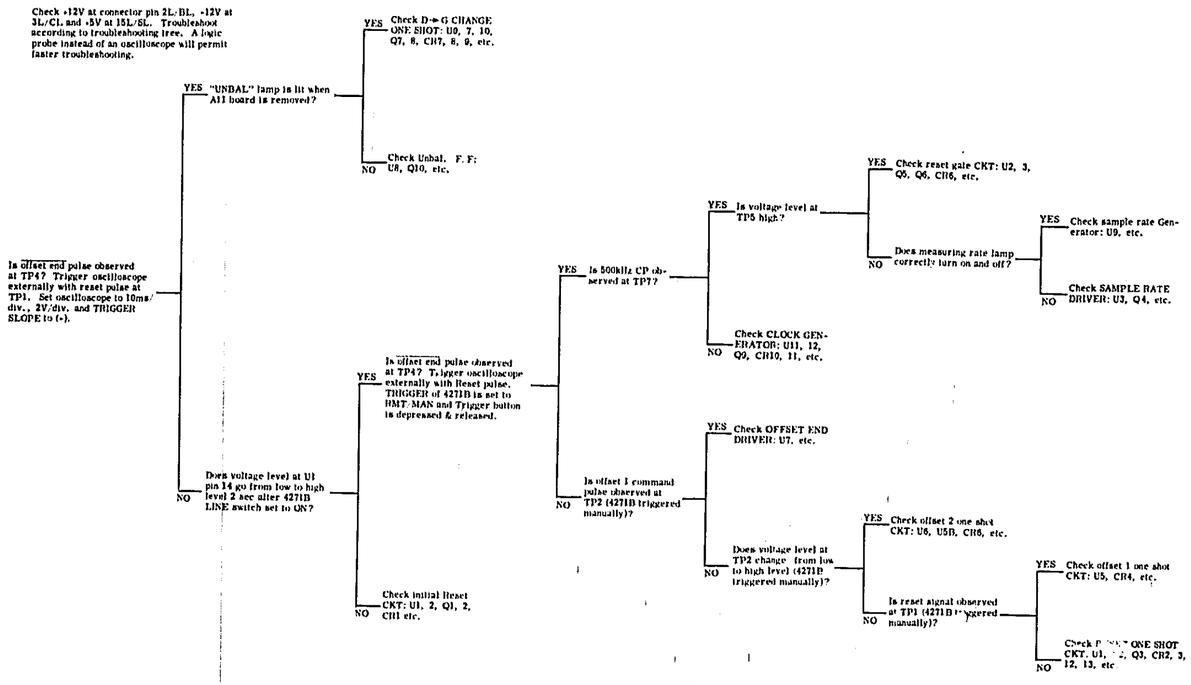


Figure 8-79. A13 Reset & Clock Pulse Generator Board Troubleshooting Tree.

A12 Rs & Offset Circuit SERVICE SHEET 12
SEE INSIDE

A13 BOARD CIRCUIT DESCRIPTION

The Block Diagram of A13 Reset/Clock Pulse Generator is shown in Figure 8-80. The reset one shot multivibrator is triggered by initial reset one shot multivibrator output, Remote Trigger signal or CPU Trig signal and generates a reset pulse with a pulse width of 50μsec. This reset pulse is fed to A14, A15 and A17 boards and resets the 4271B to its initial conditions. An offset 1 one shot multivibrator is triggered by the reset pulse and generates a pulse of 30msec pulse width during which an offset adjustment in the Analog Section is executed. The output of offset 1 one shot triggers offset 2 one shot multivibrator, the output of which is fed to A5, A15 and A17 boards. The time interval for offset 2 is 20msec. An offset end one shot is triggered by output of offset 2 one shot. The offset end pulse (4μs wide) is fed to A14 and A15 boards as a step start command. After completion of a measuring cycle, an end pulse is transferred from A14 board and triggers the sample rate generator. At the clock pulse generator, a 1MHz signal from A4 oscillator is shaped into a square wave by a differential comparator and its frequency divided into 500kHz by a 1 bit binary counter. The 500kHz clock pulse (CP) is used throughout the 4271B.

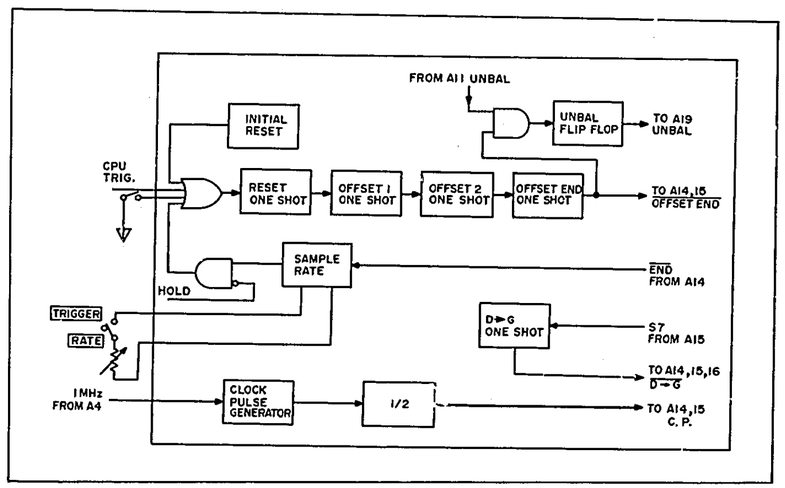


Figure 8-80. Block Diagram of A13 Board.

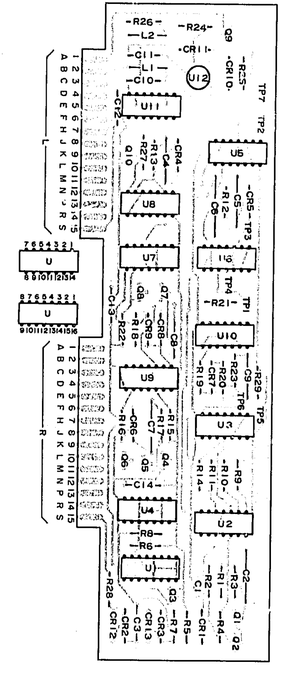


Figure 8-81. A13 Reset & Clock Pulse Generator Board Assembly Component Locations.

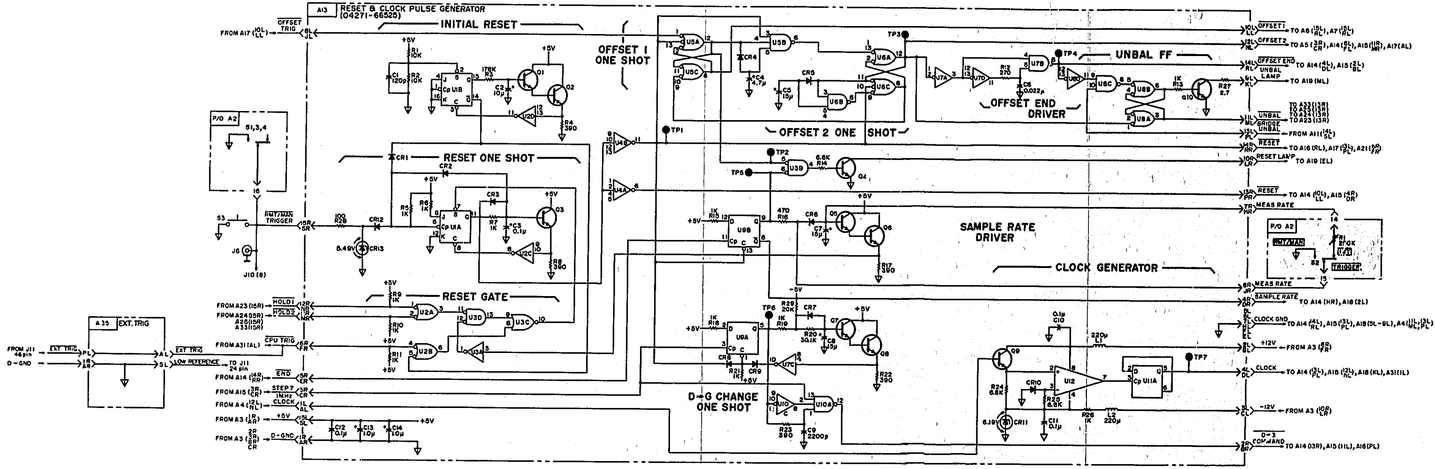


Figure 8-82. A13 Reset & Clock Pulse Generator Board Assembly Schematic Diagram.

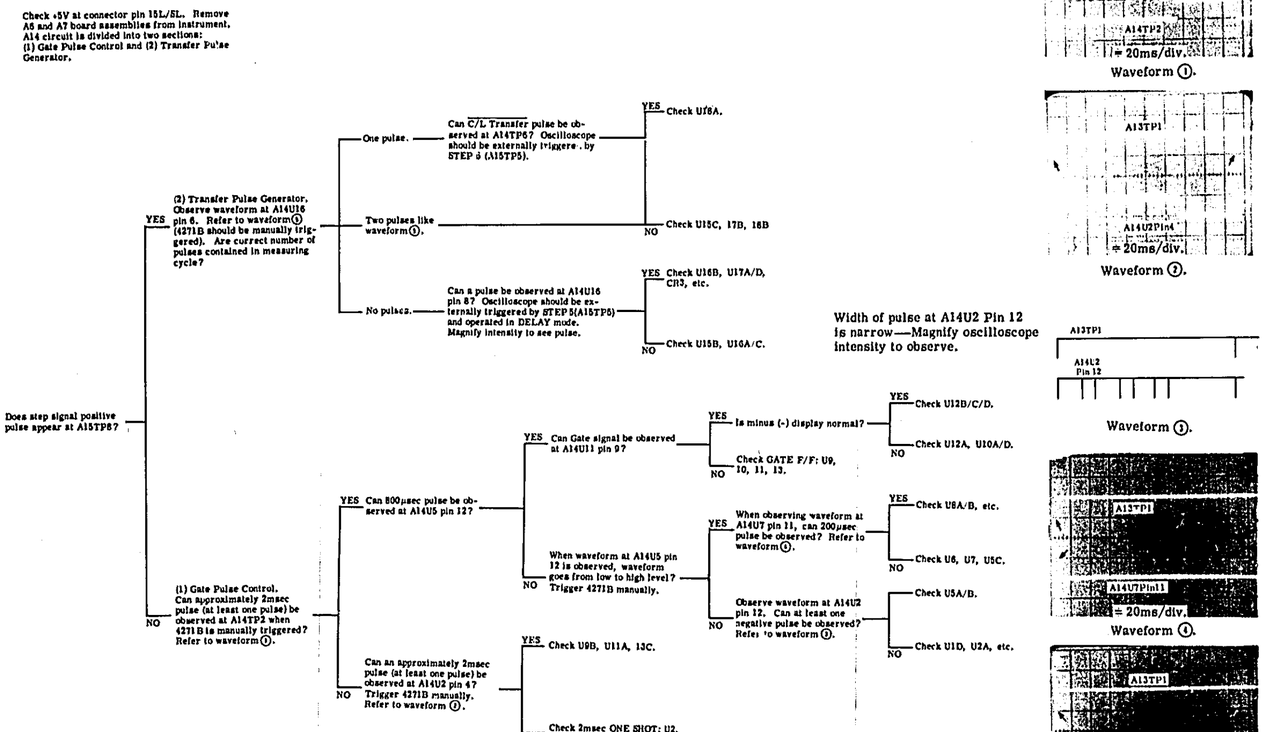


Figure 8-83. A14 Gate & Transfer Control Board Troubleshooting Tree.

A13 Reset & Clock Pulse Generator SERVICE SHEET 13
SEE INSIDE

A14 BOARD CIRCUIT DESCRIPTION

The Block Diagram of A14 Gate/Transfer Pulse Control is shown in Figure 8-84. A 2msec one shot multivibrator is triggered by a 15,920 or 10,000 signal from the A18 board, a "0" detect signal from A15 board, or an offset end signal from A13 board and the output enables generation of GATE and step shift signals. The Gate Signal controls the counter on the A18 board and the step shift signal is used as the clock pulse of the step counter on A15 board. An 800 μsec FF generates a time span of 800μsec under the condition that S_T signal is at high level. The switching of S_X and S_Y is controlled by the outputs of the 800 μsec FF and 2msec FF. The output of 800μsec FF is also used as a gate signal for minus sample measurement. The C Transfer, G Transfer and End signals are generated by a transfer pulse generator whose inputs are the step signals (step 5, step 6, and step 8) from A15 board.

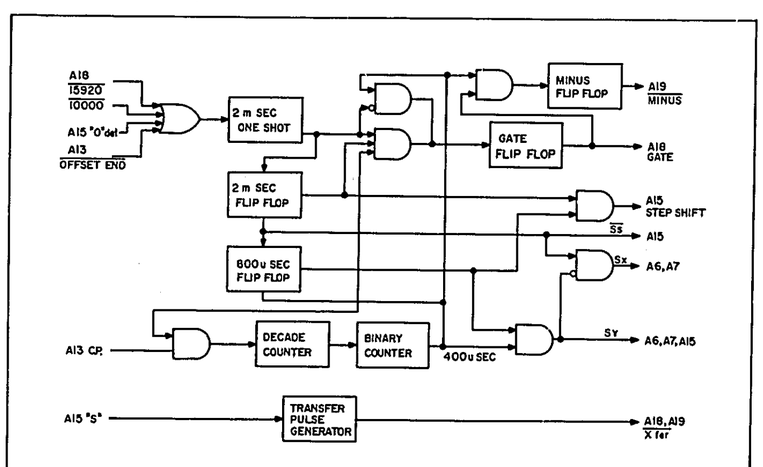


Figure 8-84. Block Diagram of A14 Board.

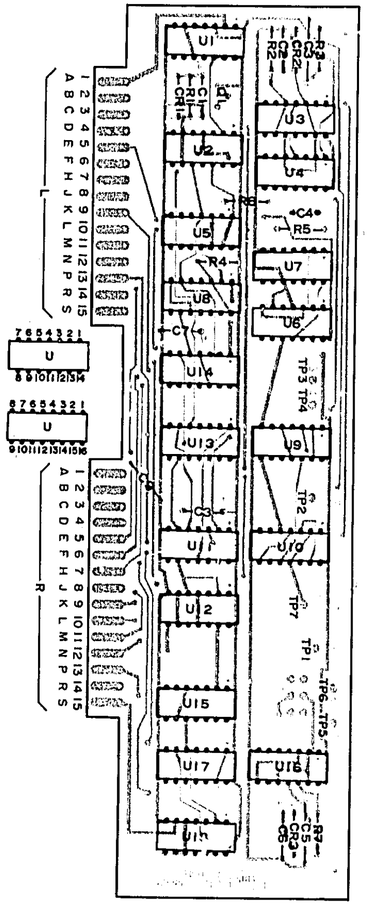


Figure 8-85. A14 Gate & Transfer Control Board Assembly Component Locations.

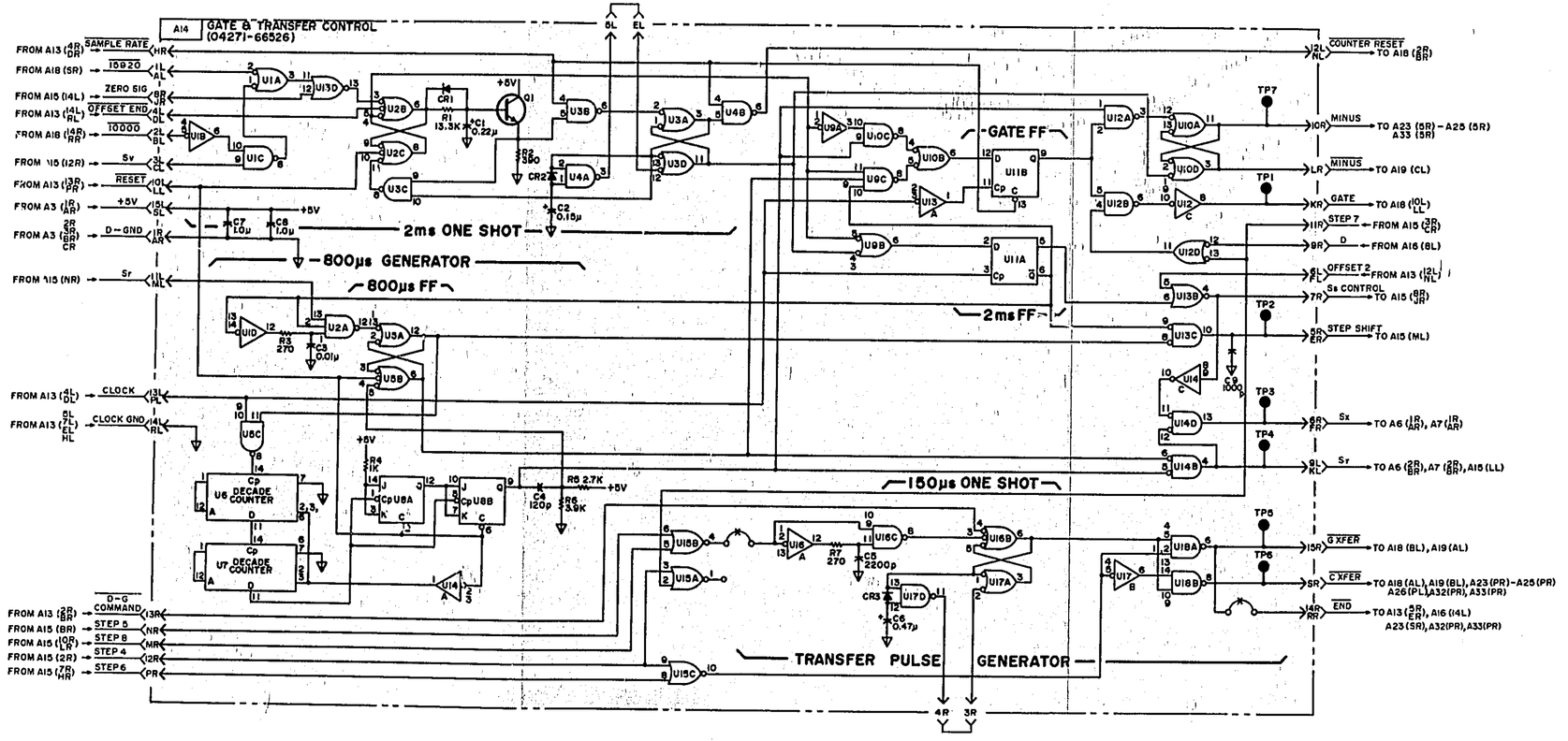
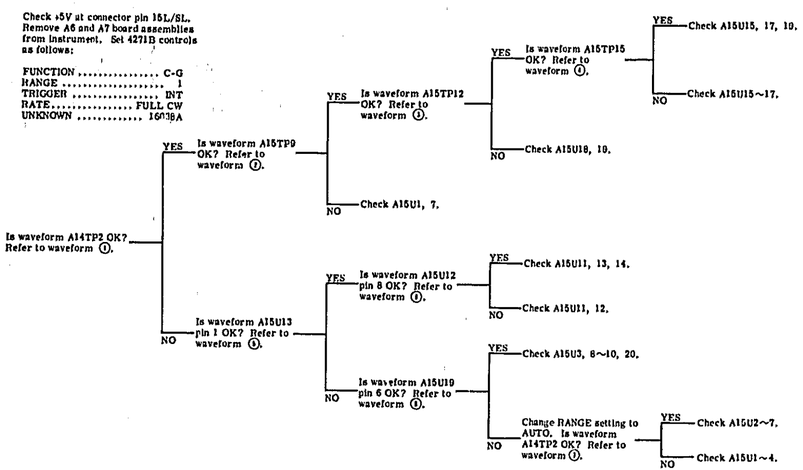
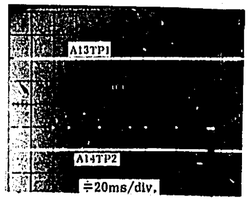
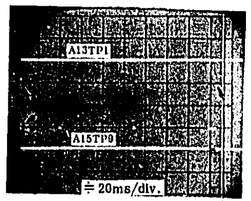


Figure 8-86. A14 Gate & Transfer Control Board Assembly Schematic Diagram.

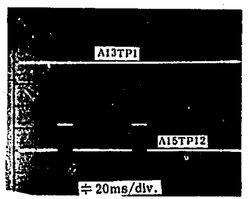




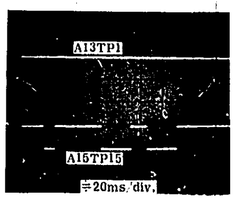
Waveform ①.



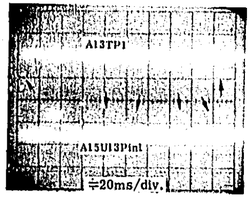
Waveform ②.



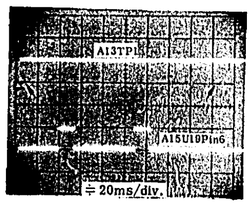
Waveform ③.



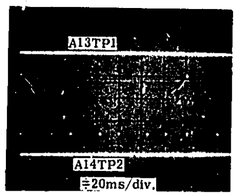
Waveform ④.



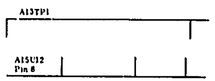
Waveform ⑤.



Waveform ⑥.



Waveform ⑦.



Waveform ⑧

Note

Width of pulse at A14U2 Pin 12 is narrow—Magnify oscilloscope intensity to observe.

Figure 8-87. A15 Step Control Board Troubleshooting Tree.

A15 BOARD CIRCUIT DESCRIPTION

The Block Diagram of A15 Step Control is shown in Figure 8-88. Step counter starts from step 1 when AUTO range is selected or from step 3 when MANUAL range is selected and advances to step 8. Each step signal, which is the high turning state of each digit of step counter, is used as a control signal for switching according to each step. $Z_{C/L}$ (output of A6 C/L Integrator is 0 volt) and $Z_{G/R}$ (output of A7 G/R Integrator is 0 volt) signals from A6 or A7 board are gated by step signals and fed to A14 board as an "0" detect signal. Switch control signals of S_R, S_D, S_G, S_C, S_Y and S_r are generated by step signals and D (D Measurement) signal. Refer to Paragraph 8-29 for timing sequence.

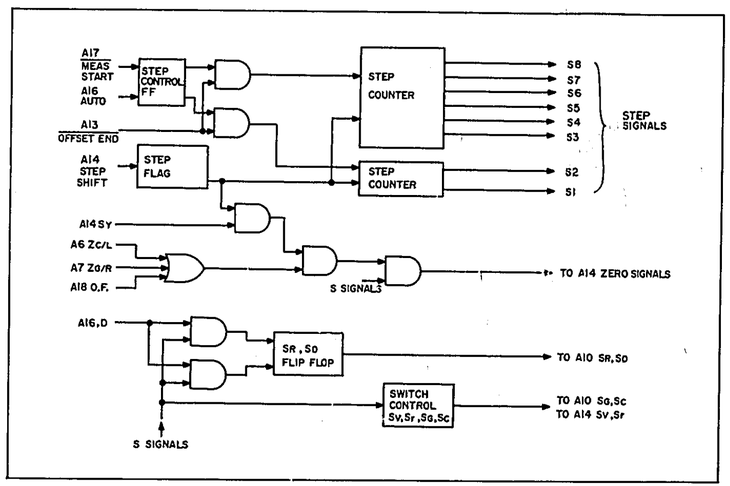


Figure 8-88. Block Diagram of A15 Board.

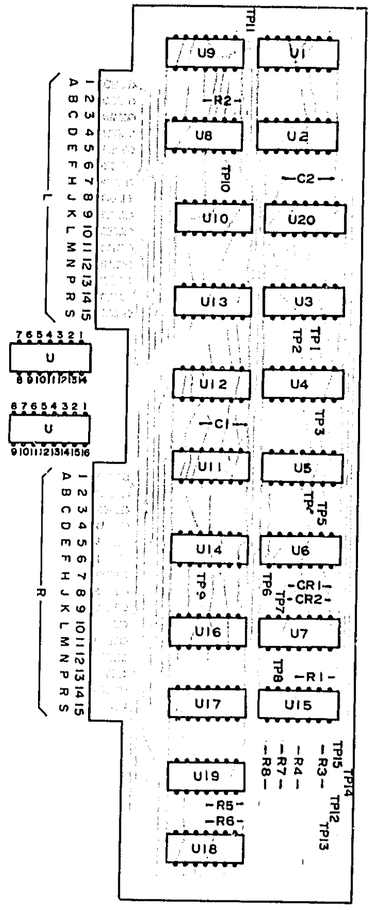


Figure 8-89. A15 Step Control Board Assembly Component Locations.

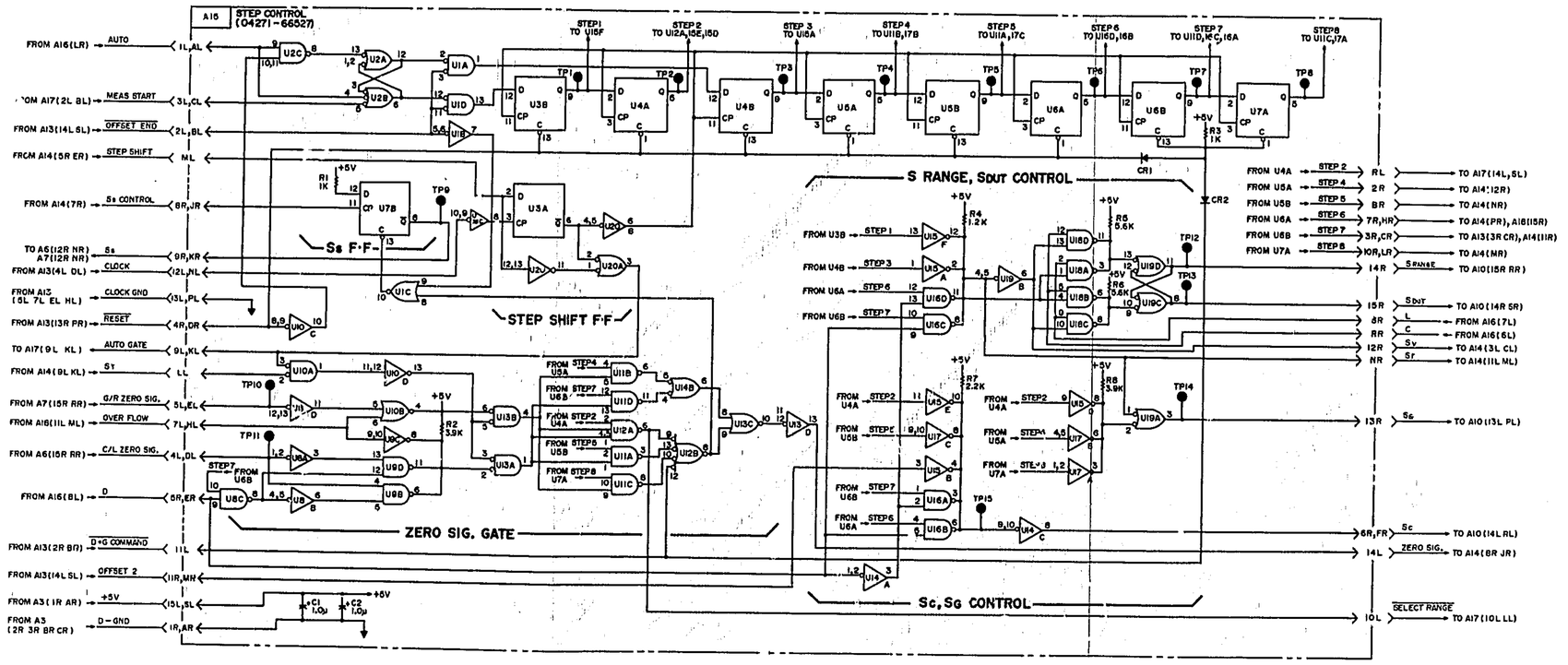


Figure 8-90. A15 Step Control Board Assembly Schematic Diagram.

Check +5V at connector pin 15L/RL. If defective part can not be isolated, proceed as follows (Set RANGE to AUTO):

Is A16 connector pin LR at high or low level?

high → Autoranging is OK?
- YES → NTF
- NO → Check U5

low → Check U14B, 9C/D, CR1~4.

Check unit and decimal point displays as shown in table below using given settings of FUNCTION and RANGE switches:

FUNCTION	RANGE	C/L Display		G/R Display	
		Decimal Point	Unit	Decimal Point	Unit
C-D	1	0.000	pF	00.00	D
	2	00.00	pF	000.0	D
	3	000.0	pF	0.000	D
	4	0.000	nF	.0000	D
C-G	1	0.000	pF	00.00	µS
	2	00.00	pF	000.0	µS
	3	000.0	µF	0.000	mS
	4	0.000	nF	00.00	mS
L-R	1	000.0	nH	0.000	Ω
	2	0.000	µH	00.00	Ω
	3	00.00	µH	000.0	Ω
	4	000.0	µH	0.000	kΩ

satisfied.

Perform following tests:
(1) "OUT OF RANGE" lamp is lit when A6 and A7 boards are removed from instrument and is not lit when A6 & A7 are not removed?
(2) Set RANGE to 4 with Unknown "open". "D→G, R" lamp is lit when FUNCTION is set to C-D and not lit when FUNCTION is set to any other position than C-D.

- (1) and (2) are satisfied. → Check U15, 16, 17, etc.
- (1) is satisfied and (2) is not satisfied. → Check U11, Q2, UTC/D, etc.
- (1) is not satisfied and (2) is satisfied. → Check U3, 9, 10, Q1, U7A/B.

not satisfied.

Are voltage levels shown in table below satisfied when operating RANGE switch of 4271B?

RANGE	A16TP2	A16TP4
1	L	L
2	H	L
3	L	H
4	H	H

YES → Voltage level shown in table below is satisfied when operating FUNCTION switch of 4271B?

FUNCTION	A16TP7	A16U12 pin 3
C-D	H	H
C-G	H	L
L-R	L	L
L-D	L	H

- YES → Check U13, 14.
- NO → Check U4, 8, 12.

NO → Are voltage levels shown in table below satisfied when operating RANGE switch?

RANGE	U1 pin 2	U1 pin 3	U1 pin 7	U1 pin 8
1	H	L	H	L
2	H	L	L	H
3	L	H	H	L
4	L	H	L	H

- YES → Check U1.
- NO → Check U2, 6, CR5~12, U14C.

Figure 8-91. A16 Function & Range Control Board Troubleshooting Tree.

A15 Step Control
SERVICE SHEET 15
SEE INSIDE

A16 BOARD CIRCUIT DESCRIPTION

The Block Diagram of A16 Function/Range Control Board is shown in Figure 8-92. Range signals from A2 or option board are decoded by Range Decoder. Function signals from A2 (or option board) are decoded into function signals of C, D, C/G and L/R, by the function decoder. Range signals and Function signals are decoded into a range switch signal for A12 by range resistor decoder. By annunciation control when OF (over flow) signal or D⟶G signal is fed to A16, Out of Range or D⟶G signal is generated and fed to A19.

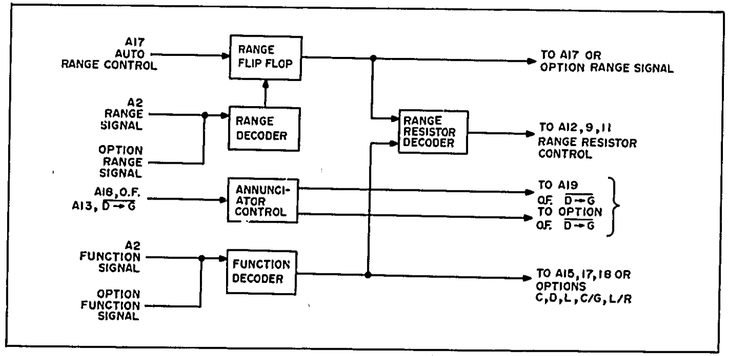


Figure 8-92. Block Diagram of A16 Board.

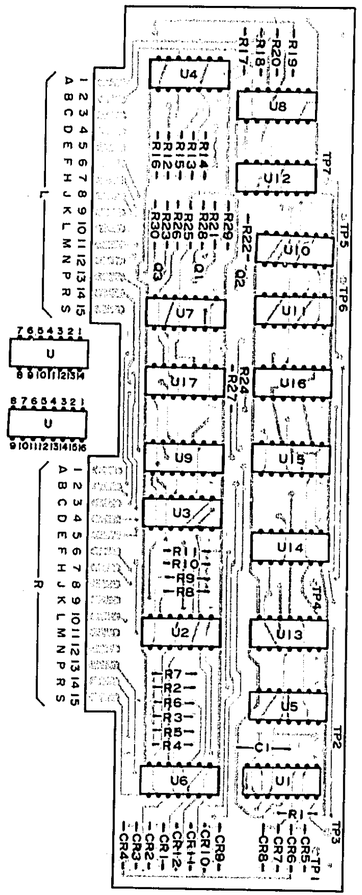


Figure 8-93. A16 Function & Range Control Board Assembly Component Locations.

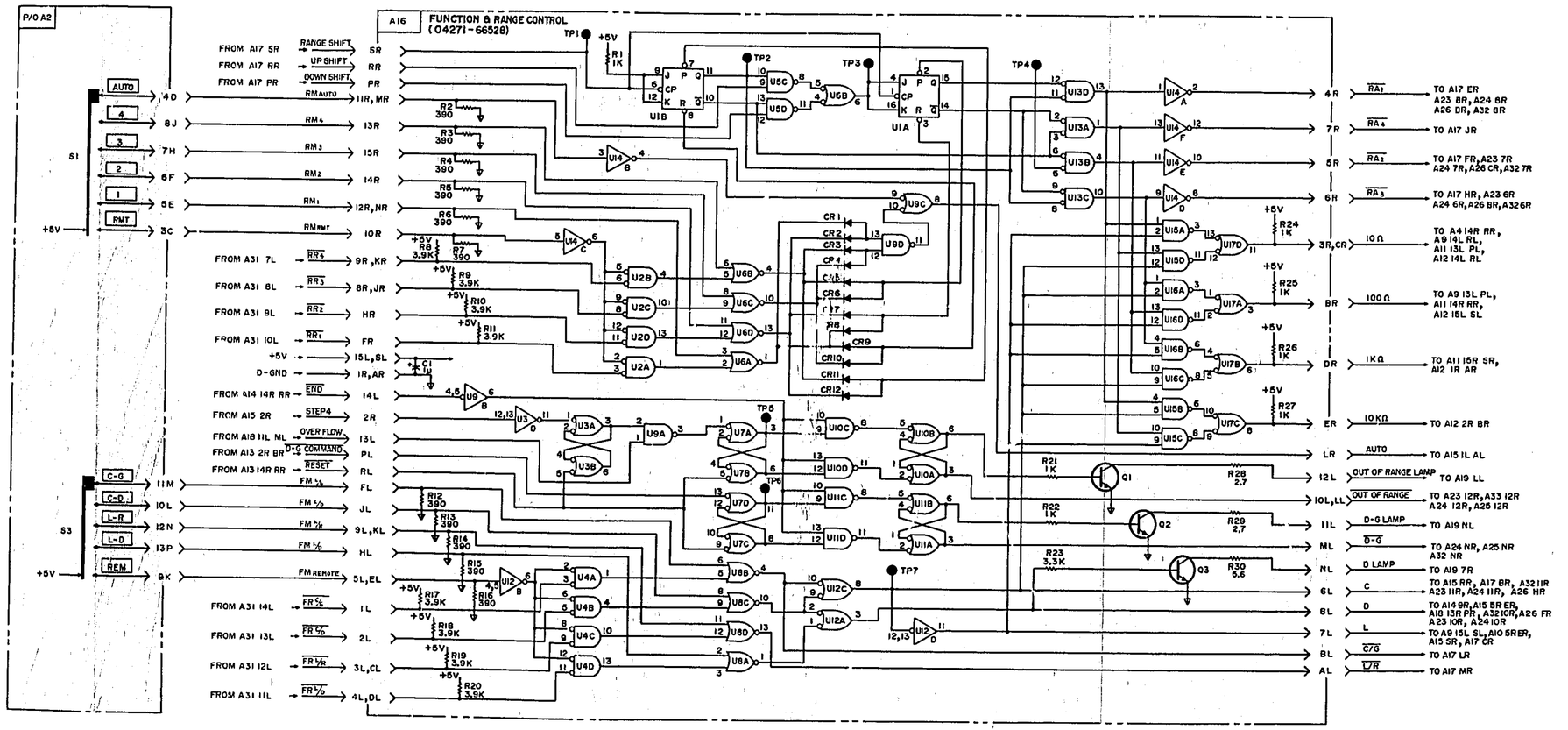
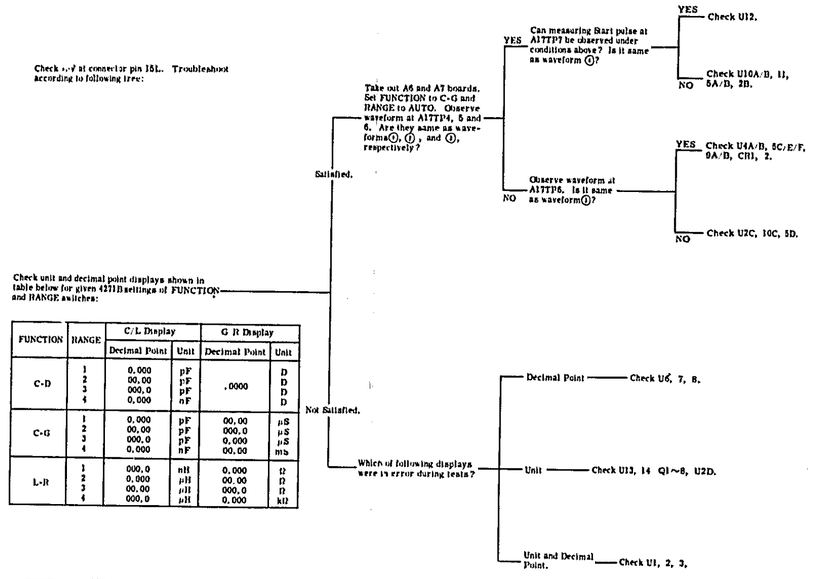


Figure 8-94. A16 Function & Range Control Board Assembly Schematic Diagram.



FUNCTION	RANGE	C/L Display		G/R Display	
		Decimal Point	Unit	Decimal Point	Unit
C-D	1	0.000	pF	.0000	D
	2	00.00	pF		D
	3	000.0	pF		D
	4	0.000	nF		D
C-G	1	0.000	pF	00.00	μS
	2	00.00	pF	000.0	μS
	3	000.0	pF	0.000	μS
	4	0.000	nF	00.00	mS
L-R	1	000.0	nH	0.000	Ω
	2	0.000	μH	00.00	Ω
	3	00.00	μH	000.0	Ω
	4	000.0	μH	0.000	kΩ

Waveform ①.

Waveform ②.

Waveform ③.

Waveform ①.

Measuring Conditions:

A6/A7 boards are removed.
FUNCTION: C-G.
RANGE: AUTO.

Figure 8-95. A17 Auto Range & Lamp Driver Board Troubleshooting Tree.

A16 Function & Range Control
SERVICE SHEET 16
SEE INSIDE

A17 BOARD CIRCUIT DESCRIPTION

Figure 8-96 is the Block Diagram of A17 Auto Range/Lamp Driver board. The driver signal to light the unit lamp on A19 and decimal point control signal to determine decimal point position on the display are generated by unit lamp driver/decimal point decoder with range and function signals from A16. An auto range control signal is generated by input signals of 1,600 and 18,000 counts from A18, select range signal and gate signal from A15, and fed to A15, A16.

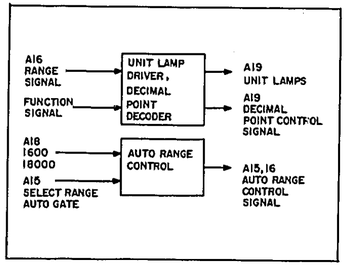


Figure 8-96. Block Diagram of A17 Board.

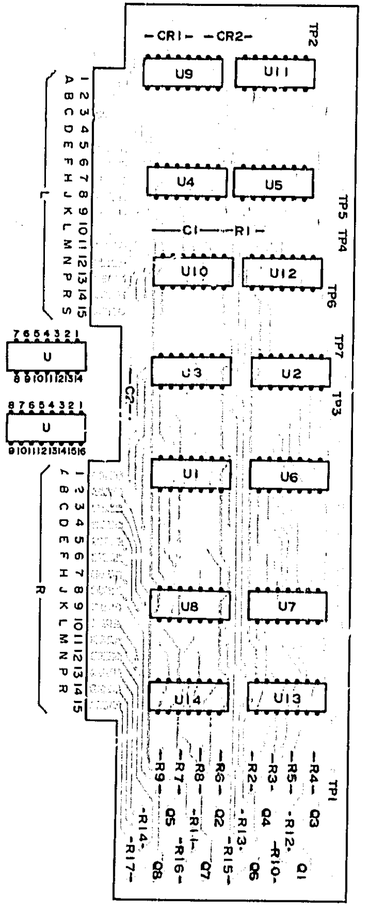


Figure 8-97. A17 Auto Range & Lamp Driver Board Assembly Component Locations.

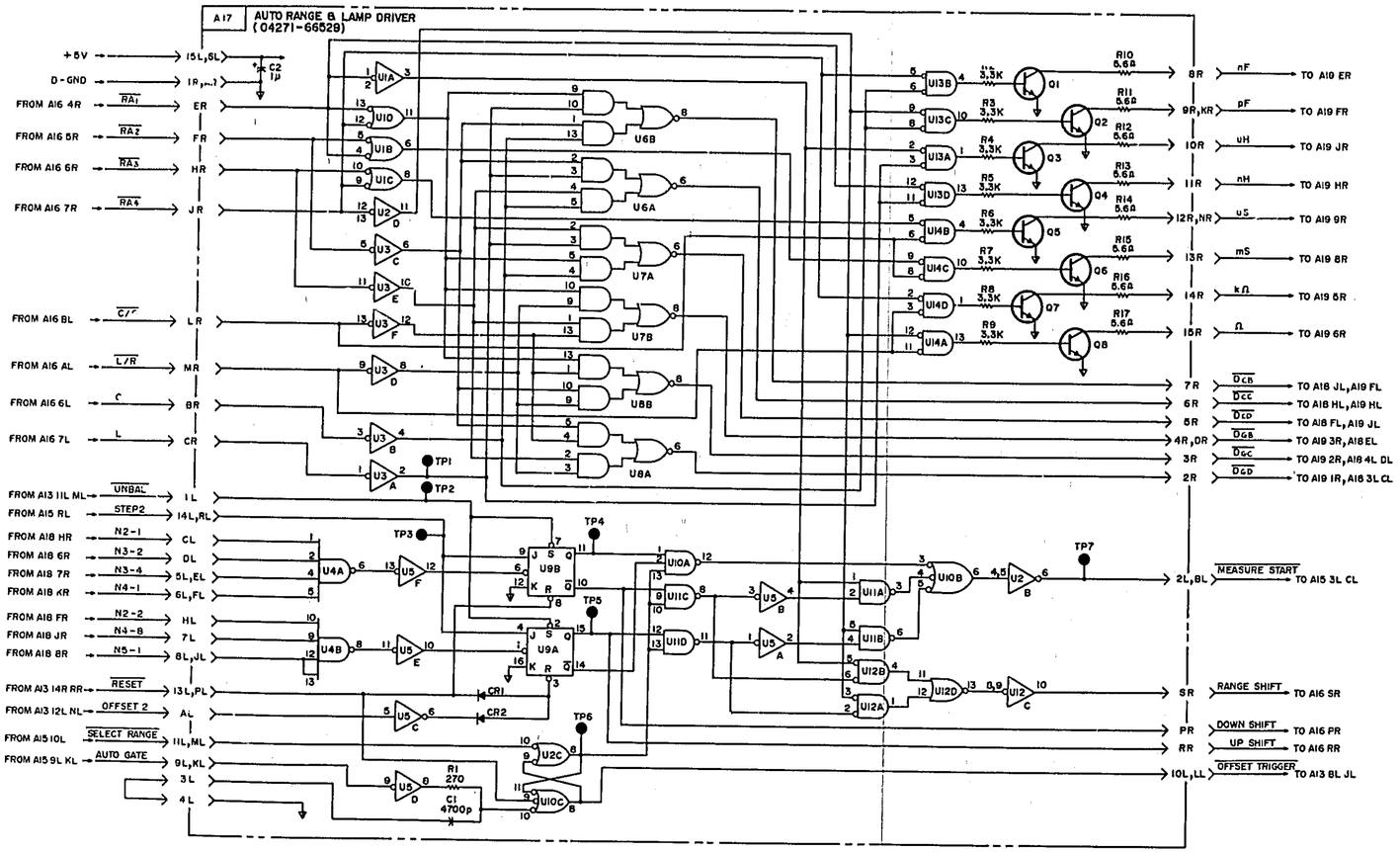


Figure 8-98. A17 Auto Range & Lamp Driver Board Assembly Schematic Diagram.

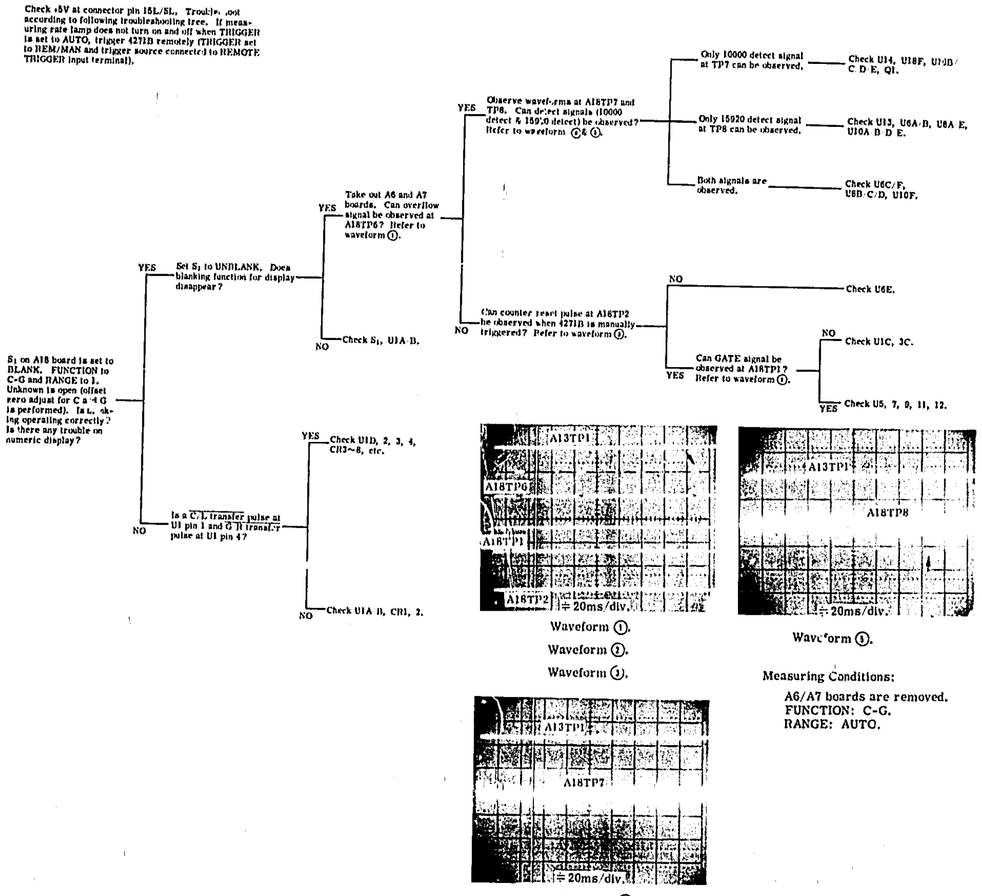


Figure 8-99. A18 Counter Board Troubleshooting Tree.

A17 Auto Range & Lamp Driver SERVICE SHEET 17
SEE INSIDE

A18 BOARD CIRCUIT DESCRIPTION

Figure 8-100 is the block diagram of A18 Counter The CP (clock pulse) is counted by the decade counter and binary counter with gate signal from A14. This count is transmitted as BCD information to A19. A 10,000 detect signal and 15,920 detect signal are generated and transmitted to A14. Meaningless digits are blanked with the blanking control as commanded by the sample rate signal from A13, transfer pulses from A14 and decimal point control signals from A17. An OF (over flow) signal is generated by the binary counter.

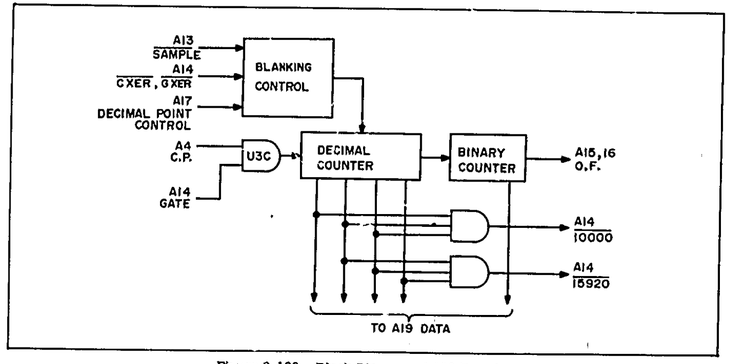


Figure 8-100. Block Diagram of A18 Board.

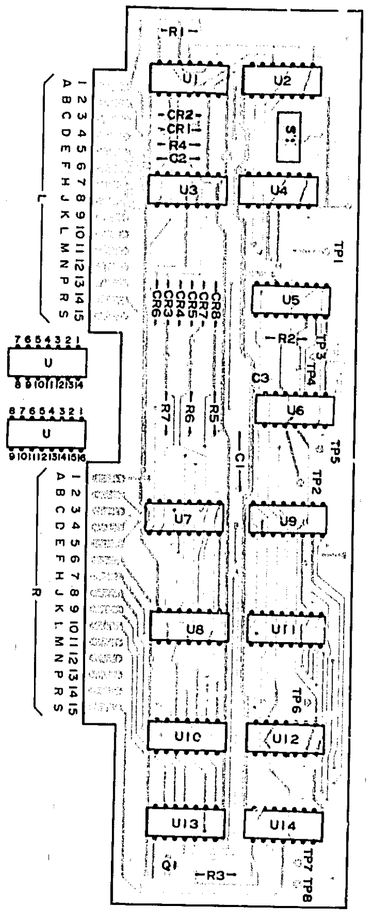


Figure 8-101. A18 Counter Board Assembly Component Locations.

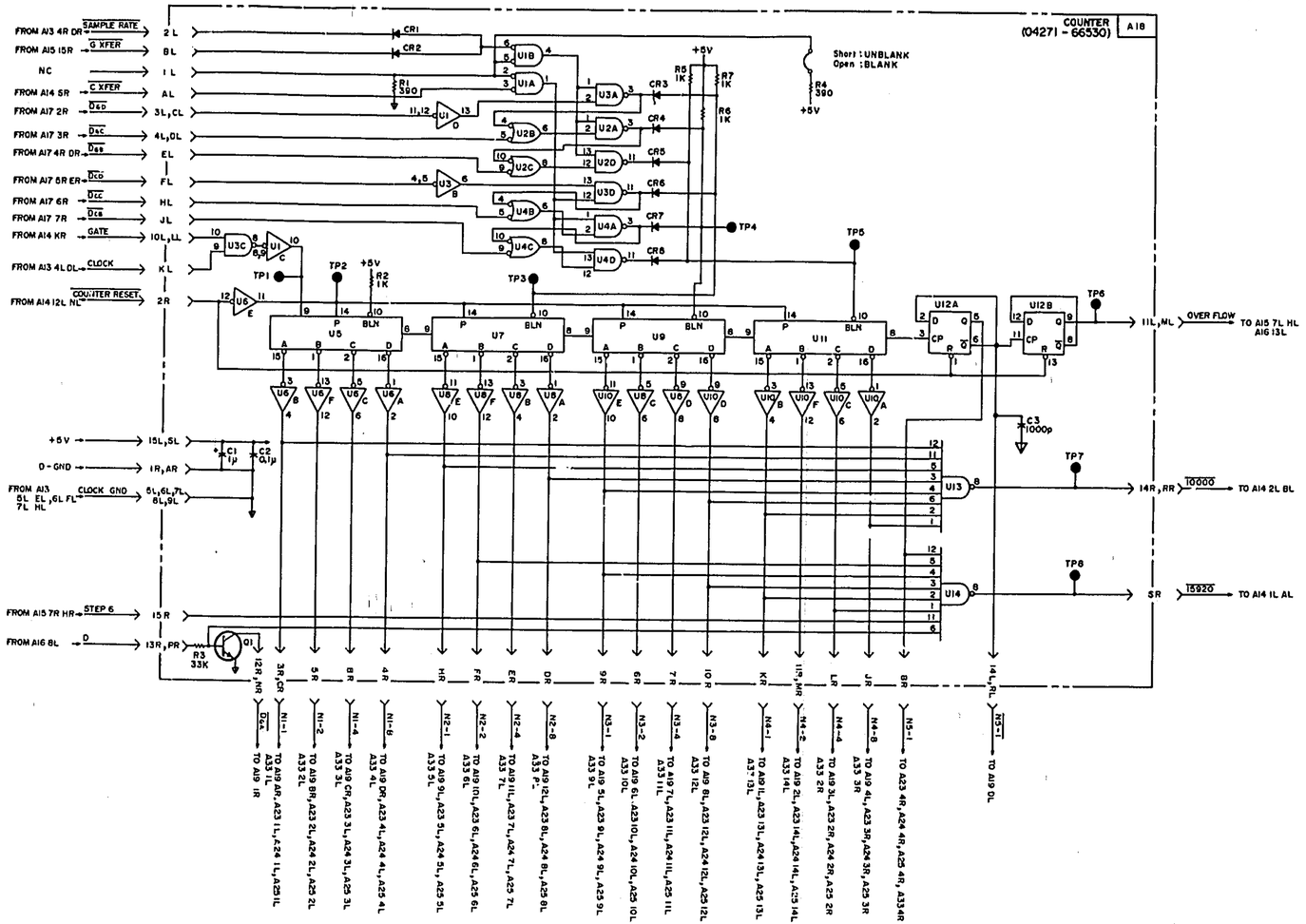


Figure 8-102. A18 Counter Board Assembly Schematic Diagram.

A19 Troubleshooting

Check +5V at connector pin 10R/LR. Most A19 troubles can be solved by Front Panel operation. The following table shows how to light each display. Trouble can be isolated to display that can not be lit (or turned on and off).

Procedure	Display Lit
Remove A6/A7 boards from instrument.	"OUT OF RANGE"
Remove A11 board from instrument.	"UNBAL"
Set FUNCTION to C-G and RANGE to 4. Set TRIGGER to INT. Connect capacitor of less than 100pF to Unknown terminal.	"D→G, R"
Trigger 4271B manually.	Measuring Rate Lamp or A19R1.
Control FUNCTION and RANGE as shown table below:	Decimal Point and Unit.
Set FUNCTION to C-G and RANGE to 1. Connect nothing to test leads or fixture (0pF). Adjust C/G OFFSET ADJ to display minus "-".	"-" (minus) or CR1/R2.
Remove A6/A7 boards from instrument. "0000" is displayed on both displays.	Numeric Display
If trouble is not found by all above, check DS1/DS6.	DS1/DS6

FUNCTION	RANGE	C, L Display		G, R Display	
		Decimal Point	Unit	Decimal Point	Unit
C-D	1	0.000	pF	.0000	D
	2	00.00	pF		D
	3	000.0	pF		D
	4	0.000	nF		D
C-G	1	0.000	pF	00.00	μS
	2	00.00	pF	000.0	μS
	3	000.0	pF	0.000	μS
	4	0.000	nF	00.00	mS
L-R	1	000.0	nH	0.000	Ω
	2	0.000	μH	00.00	Ω
	3	00.00	μH	000.0	Ω
	4	000.0	μH	0.000	kΩ

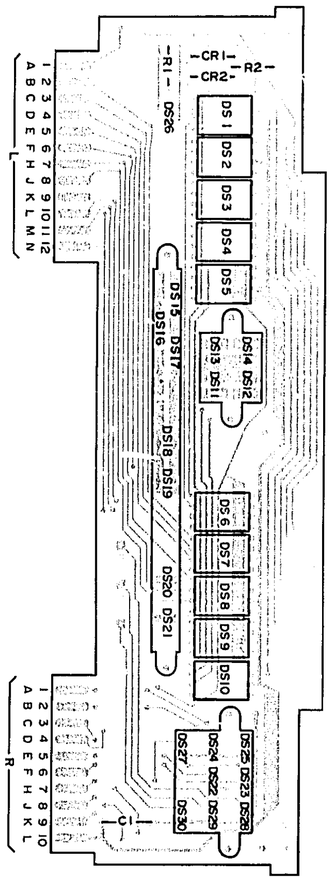


Figure 8-103. A19 Display Board Assembly Component Locations.

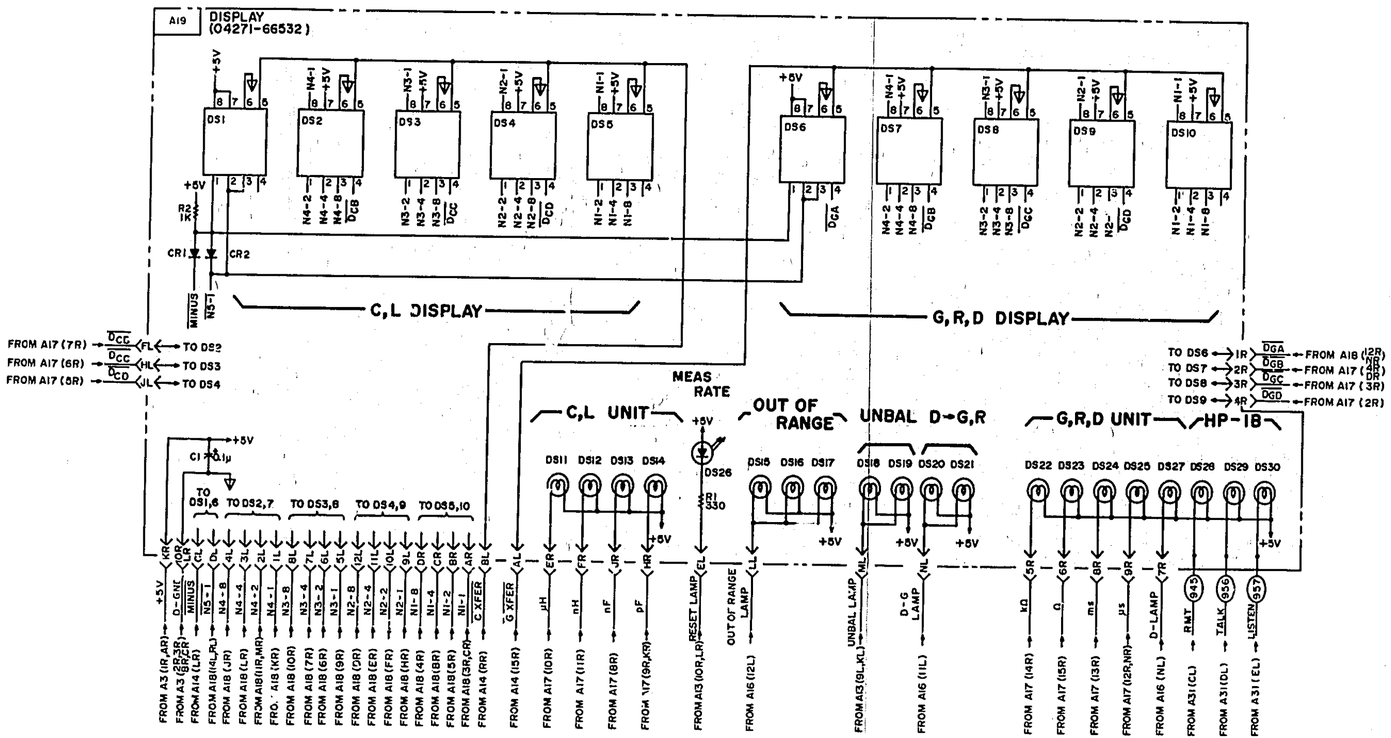


Figure 8-104. A19 Display Board Assembly Schematic Diagram.

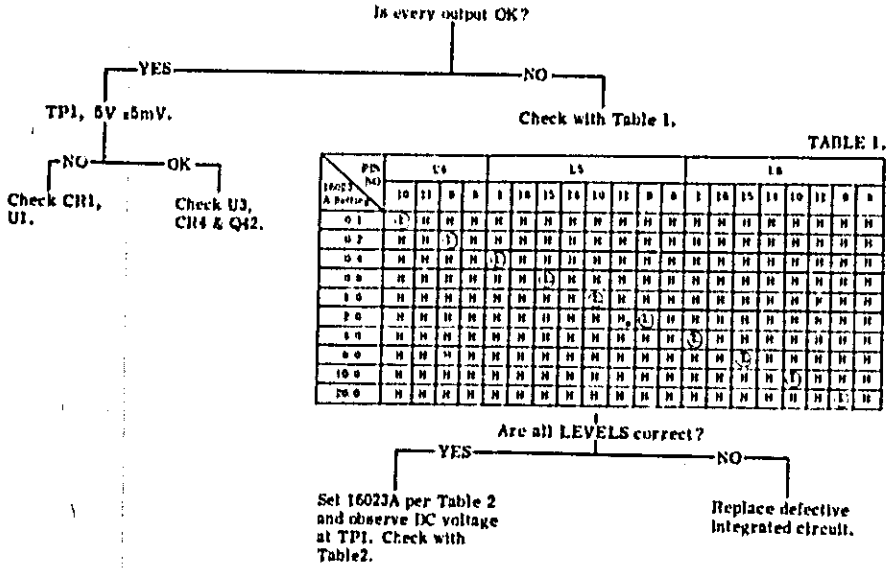


TABLE 2.

PIN NO / 16023A Setting	Voltage at TP1	Check Following Transistors			
0.1	0.1	Q1	Q2	Q21	Q22
0.2	0.2	Q3	Q4	Q23	Q24
0.4	0.4	Q5	Q6	Q25	Q26
0.8	0.8	Q7	Q8	Q27	Q28
1.0	1.0	Q9	Q10	Q29	Q30
2.0	2.0	Q11	Q12	Q31	Q32
4.0	4.0	Q13	Q14	Q33	Q34
8.0	8.0	Q15	Q16	Q35	Q36
10.0	10.0	Q17	Q18	Q37	Q38
20.0	20.0	Q19	Q20	Q39	Q40

Figure 8-105. A21 DC Bias Supply Board Troubleshooting Tree

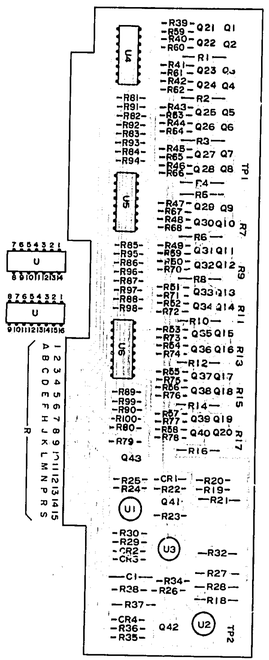


Figure 8-106. A21 DC Bias Supply Board Assembly Component Locations.

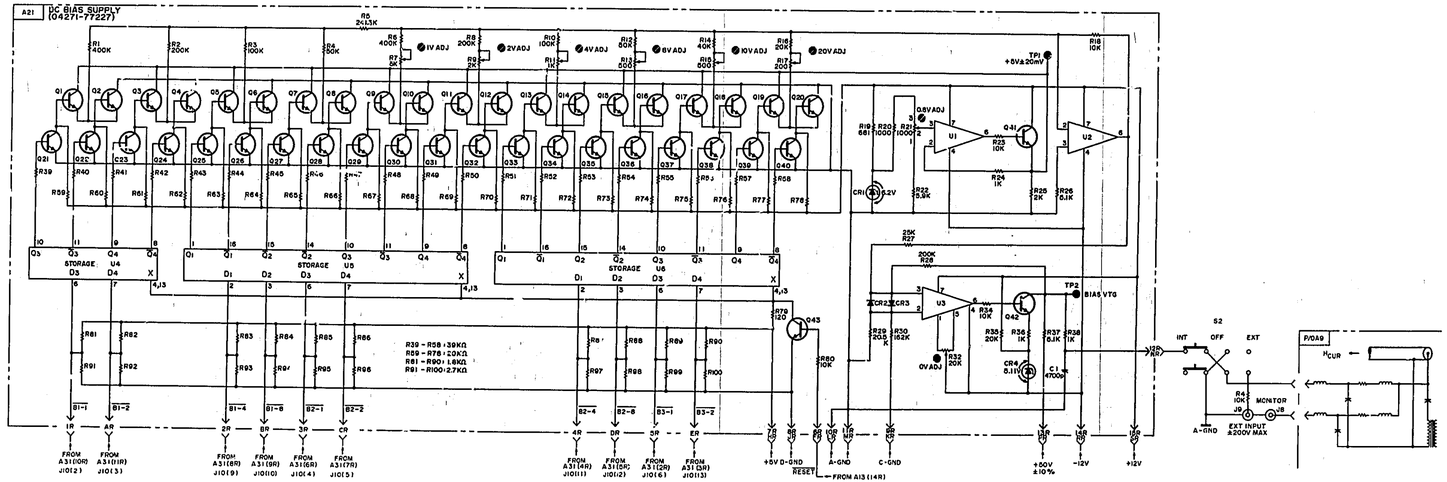


Figure 8-107. A21 DC Bias Supply Board Assembly Schematic Diagram.

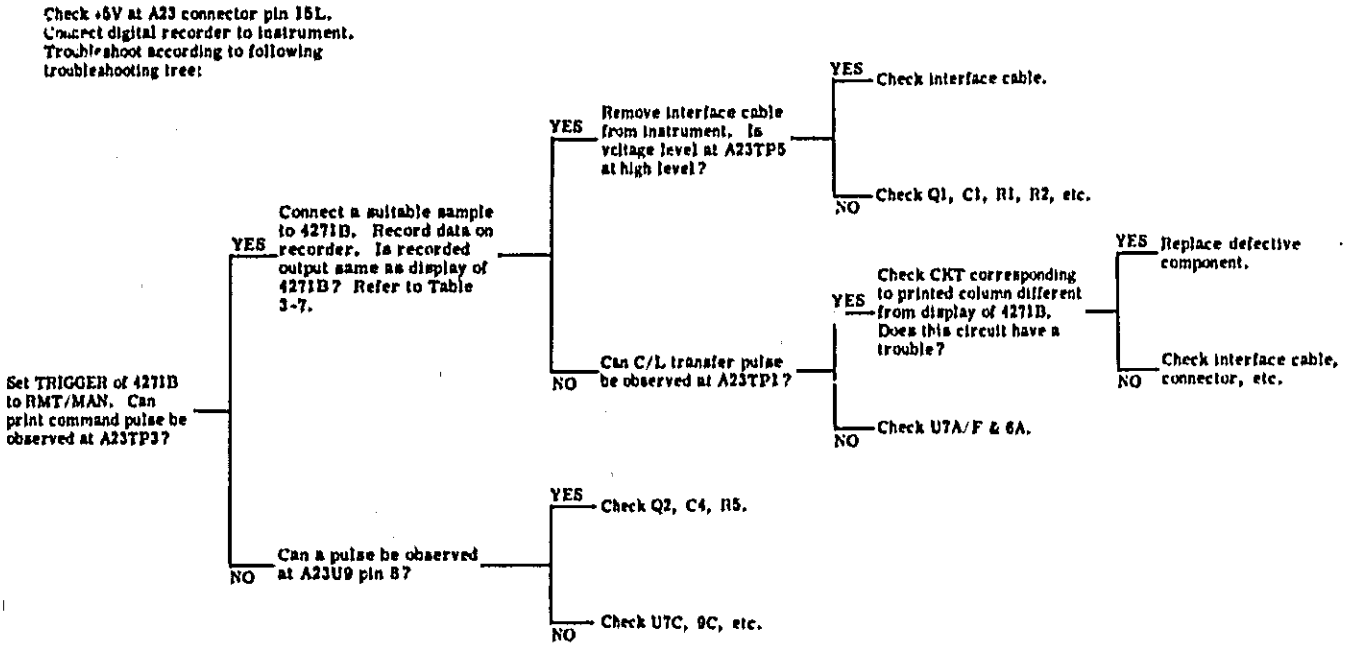


Figure 8-108. A23 C/L BCD Output Board Troubleshooting Tree.

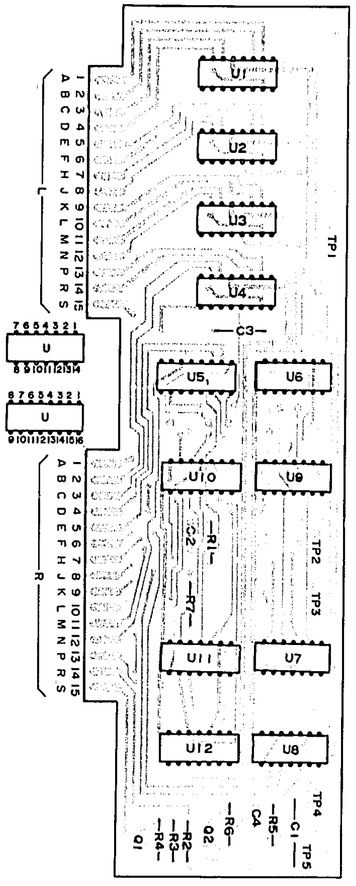


Figure 8-109. A23 C/L BCD Output Board Assembly Component Locations.

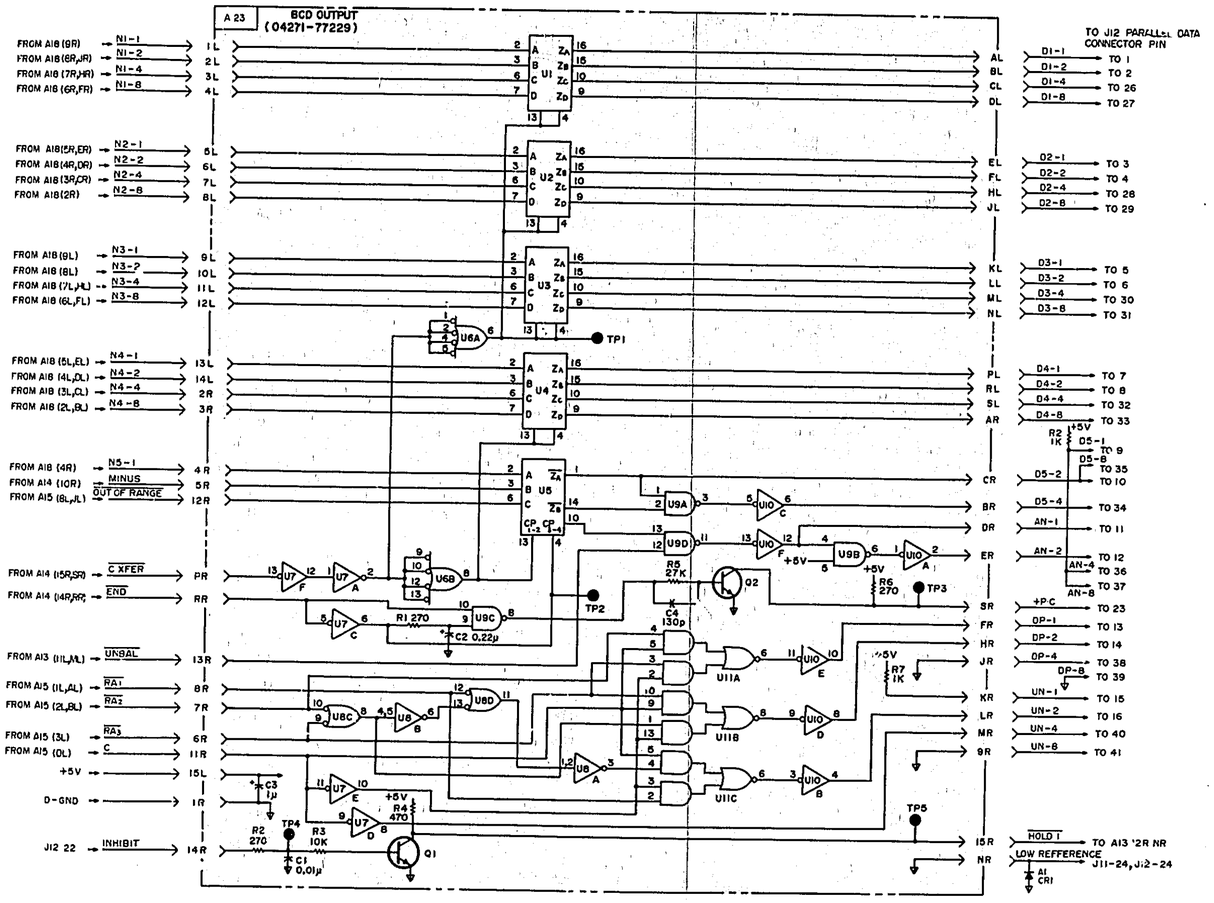


Figure 8-110. A23 C/L BCD Output Board Assembly Schematic Diagram.

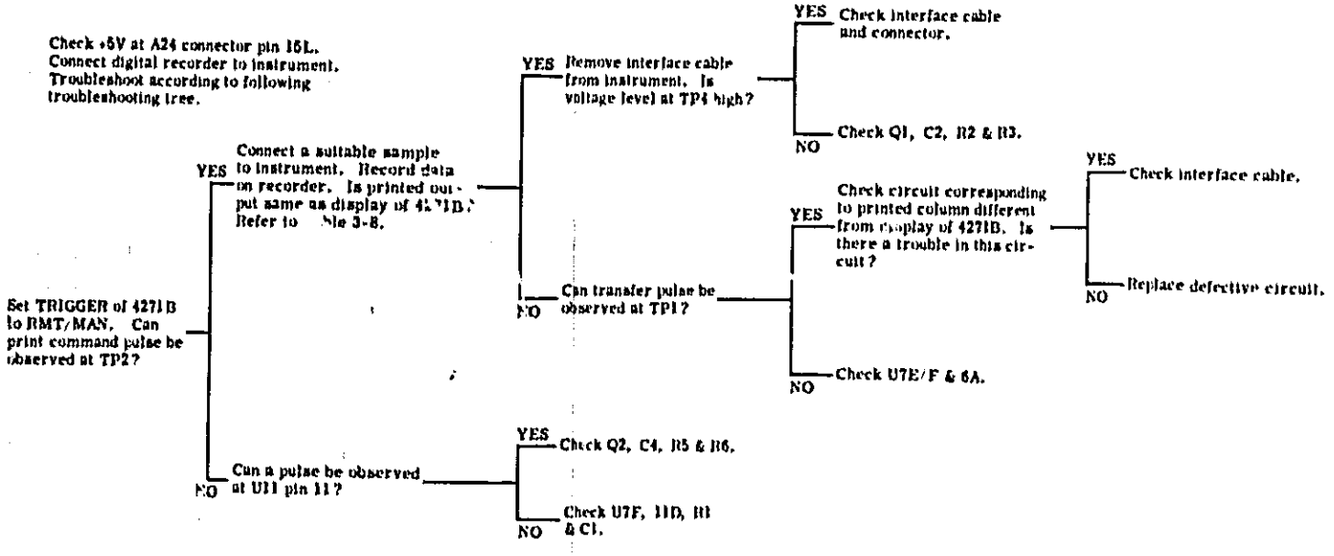


Figure 8-111. A24 G/R/D BCD Output Board Troubleshooting Tree.

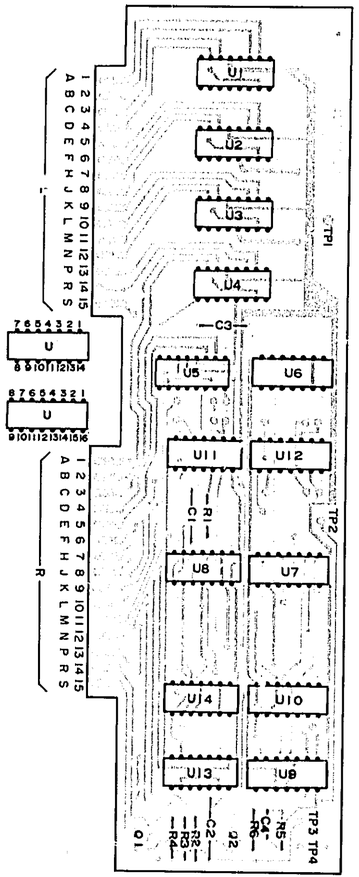


Figure 8-112. A24 G/R/D BCD Output Board Assembly Component Locations.

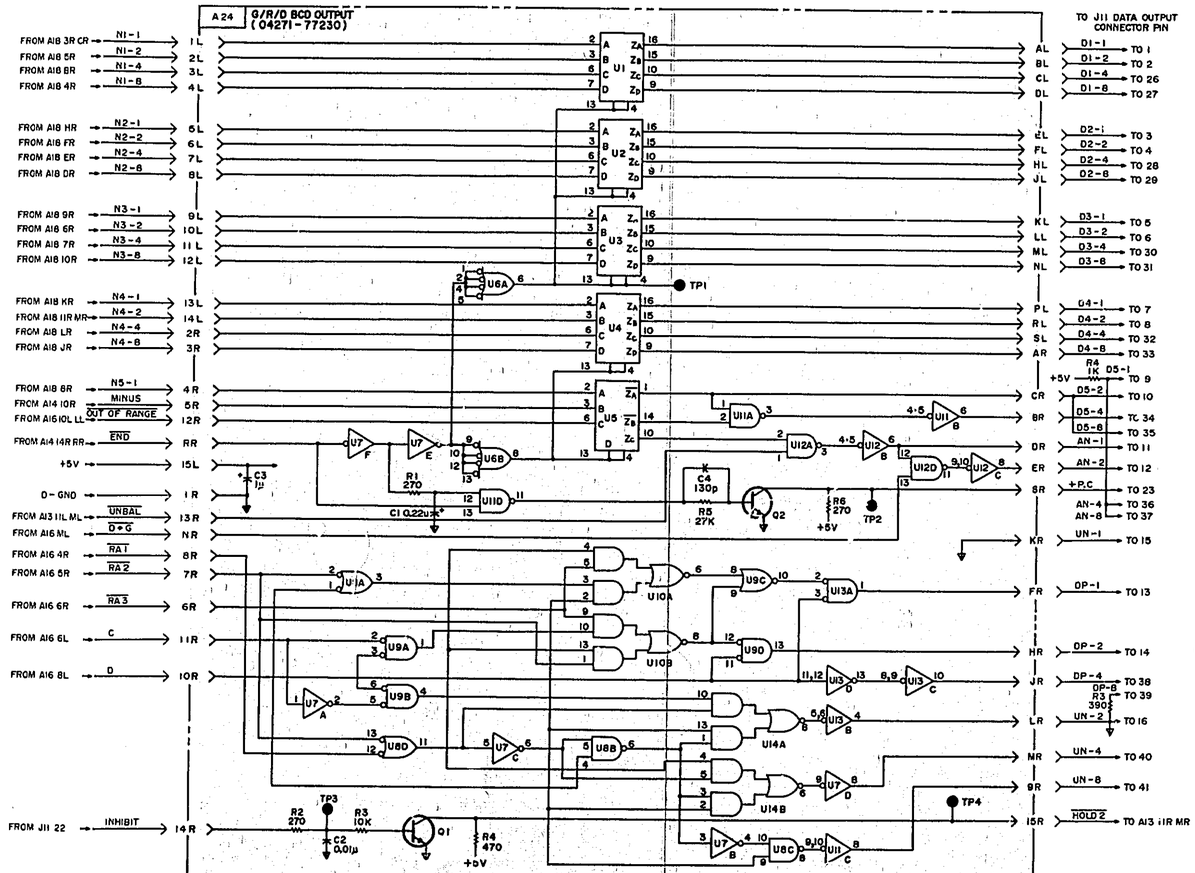
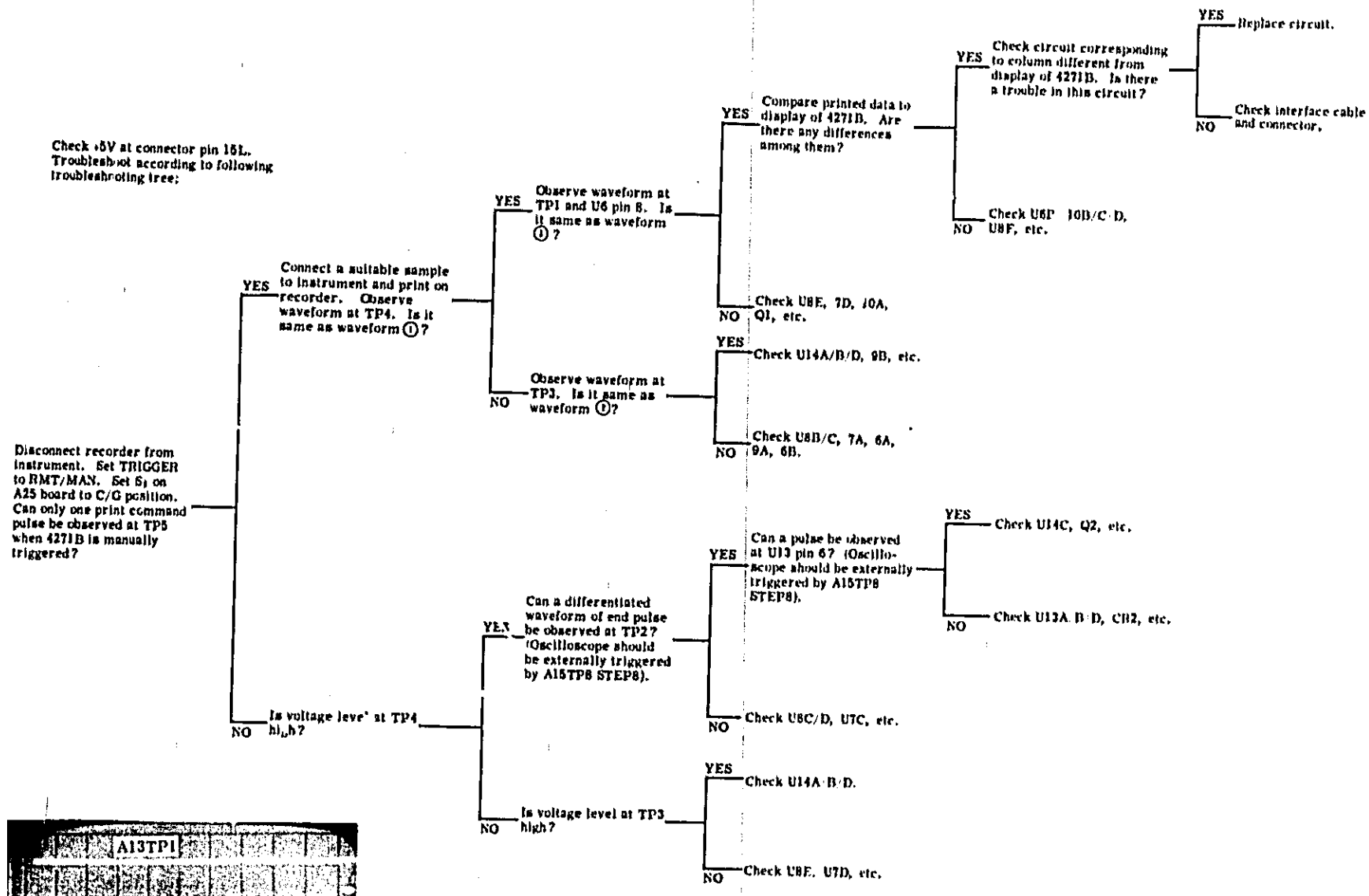
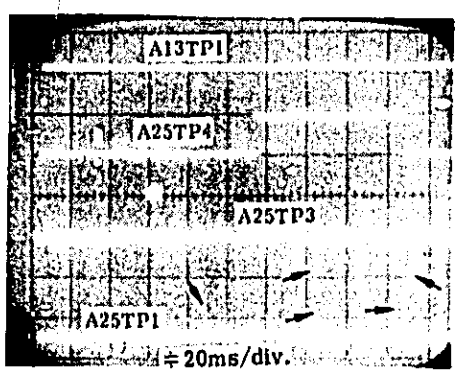


Figure 8-113. A24 G/R/D BCD Output Board Assembly Schematic Diagram.





Waveform ①.

Waveform ②.

Waveform ③.

Measuring Conditions:

FUNCTION: C-G.
RANGE: AUTO.
TRIGGER: INT.

Figure 8-114. A25 Parameter Serial BCD Output Control Board Troubleshooting Tree.

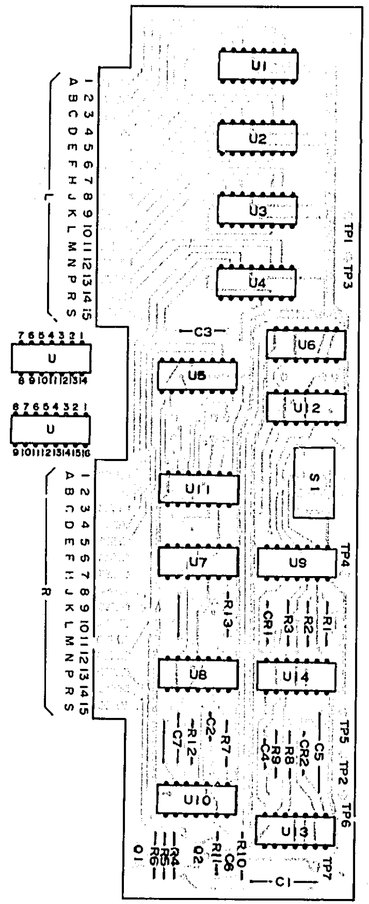


Figure 8-115. A25 Parameter Serial BCD Output Control Board Assembly Component Locations.

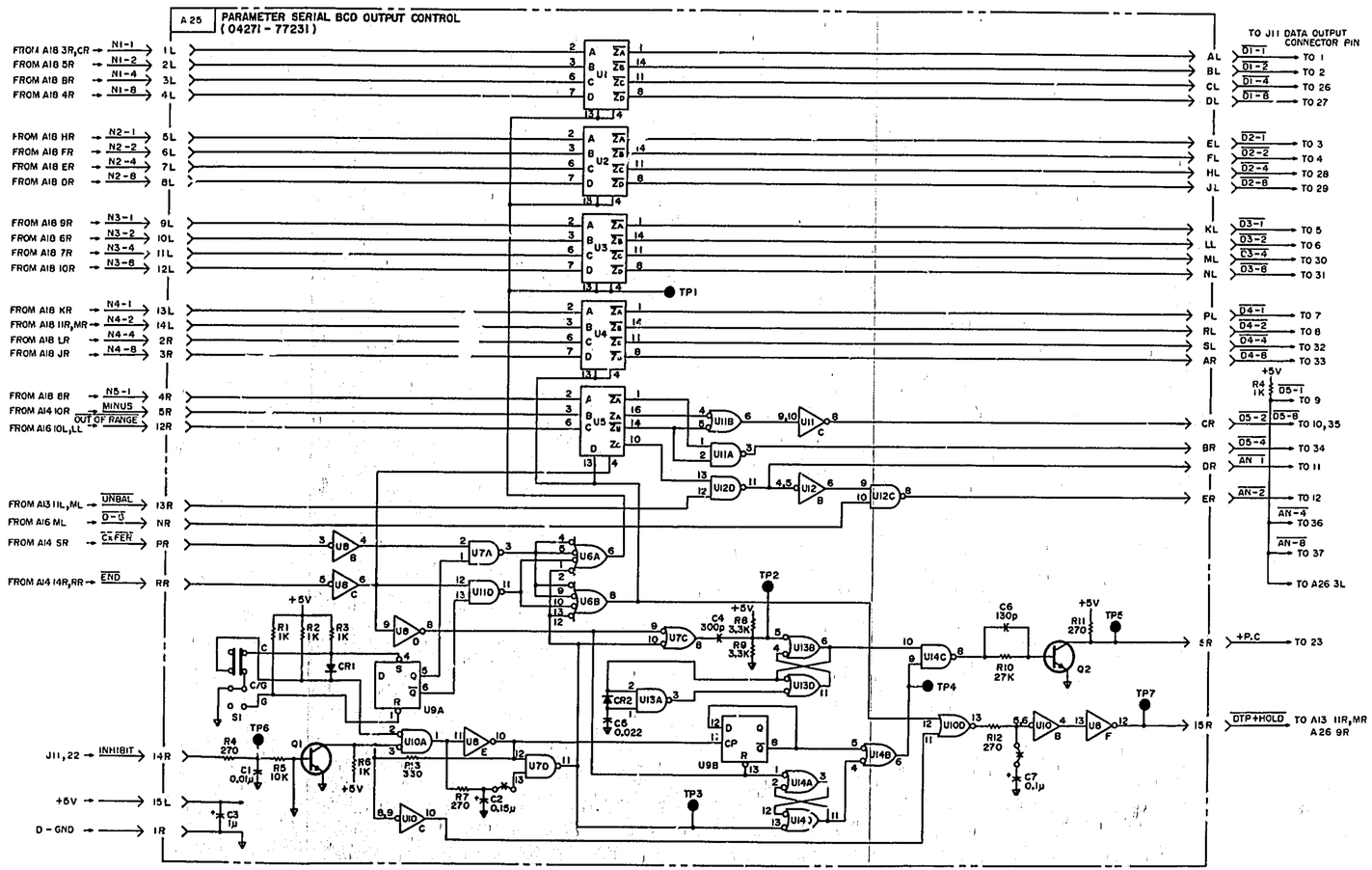


Figure 8-116. A25 Parameter Serial BCD Output Control Board Assembly Schematic Diagram.

Check +5V at connector pin 15L/5L. Troubleshoot according to following troubleshooting tree:

Note

For performing this tree, A25 board must be installed.

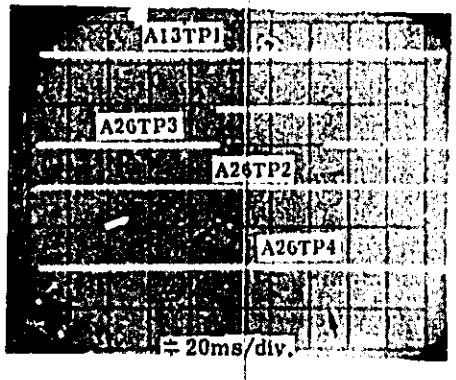
Set TRIGGER of 4271B to INT. Set S_1 on A25 board to C/G. Observe waveform at TP3. Is it same as waveform ①?

YES — Compare unit and data multiplication signals to display of 4271B. Refer to Table 3-9.

- Only unit is different from display. → Check U4A/C/E, 7A/B/C, U11, U12 & U14.
- Only data multiplication is different from display. → Check U4F, U5, 6, U8A/B/D, U9B/C, U10 and U13A/C/D.
- Both unit and data multiplication are different from display. → Check U3, U4B/D & U13B.

NO — Observe waveform at TP2. Is it same as waveform ①?

- YES — Observe waveform at TP4. Is it same as waveform ①?
  - YES → Check U1A/E, U2B/C, Q1, etc.
  - NO → Check U2A/B.
- NO → Check U1C/D, 8C.



Waveform ①.

Waveform ②.

Waveform ③.

Measuring Conditions:

FUNCTION: C-G.
RANGE: AUTO.
TRIGGER: INT.
Unknown Device. ≈100pF.

Figure 8-117. A26 Parameter Serial BCD Output Decoder Board Troubleshooting Tree.

8-84

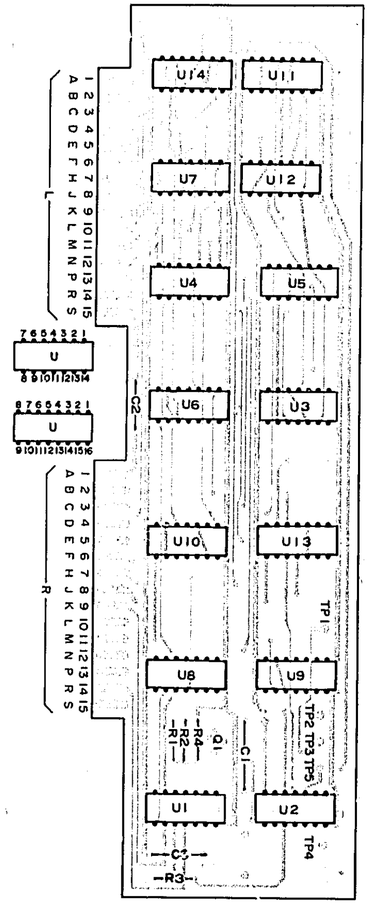


Figure 8-118. A26 Parameter Serial BCD Output Control Board Assembly Component Locations.

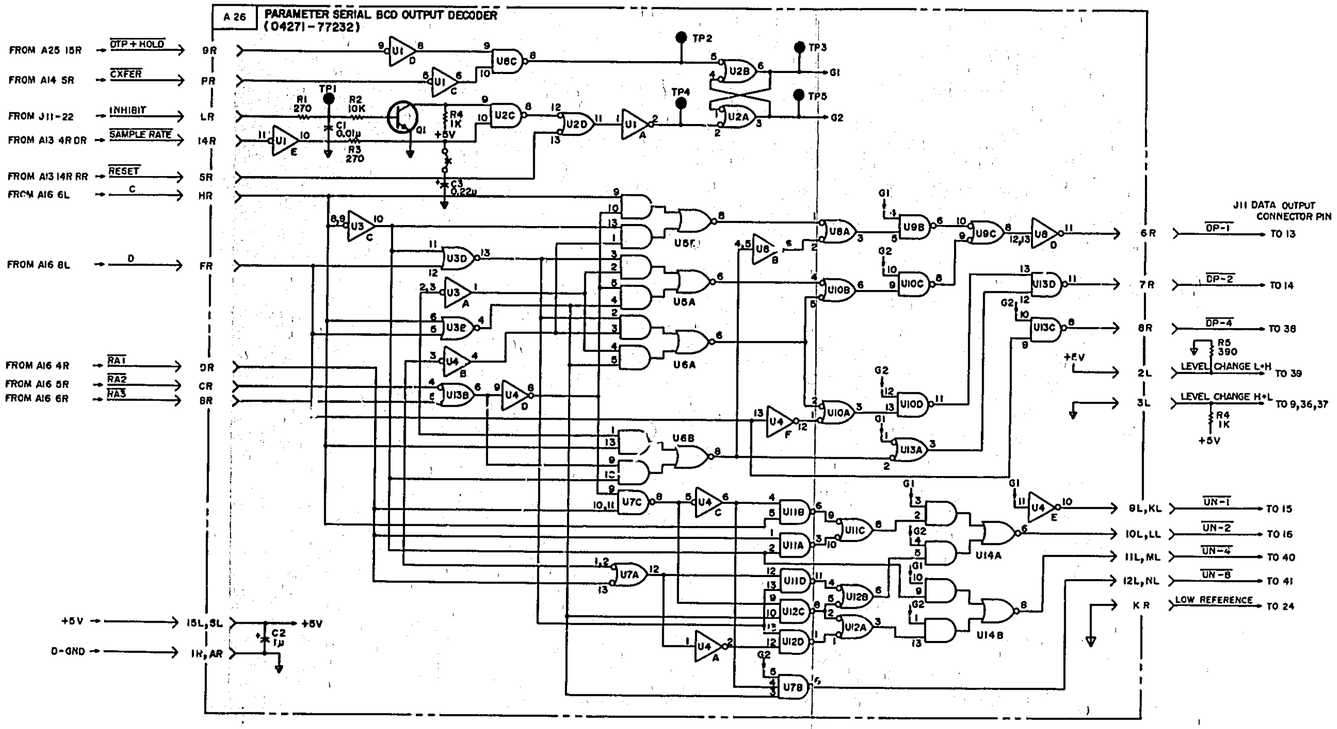


Figure 8-119. A26 Parameter Serial BCD Output Decoder Board Assembly Schematic Diagram.

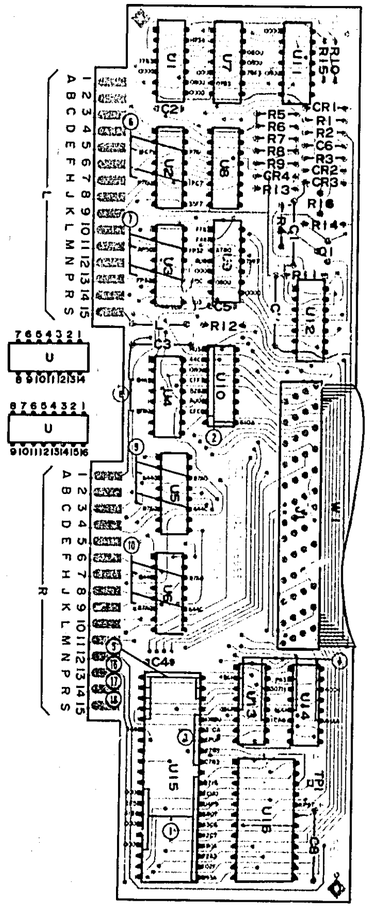


Figure 8-120. A31 HP-IB CPU Board Assembly Component Locations.

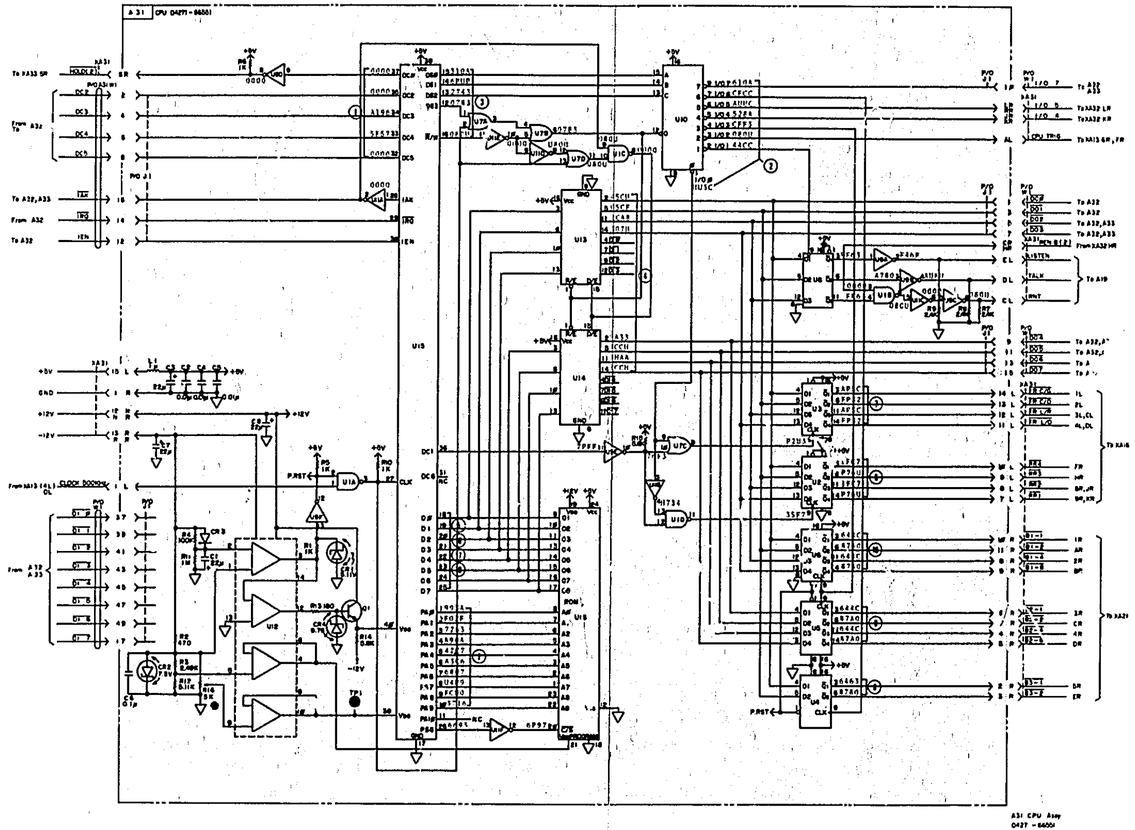


Figure 8-121. A31 HP-IB CPU Board Assembly Schematic Diagram.

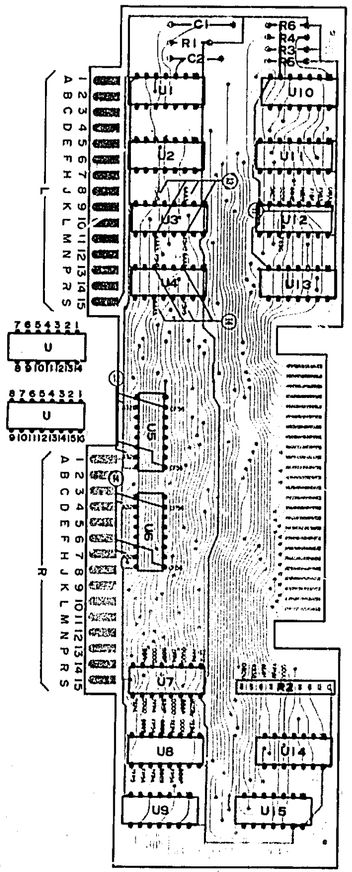


Figure 8-122. A32 HP-IB Control Board Assembly Component Locations.

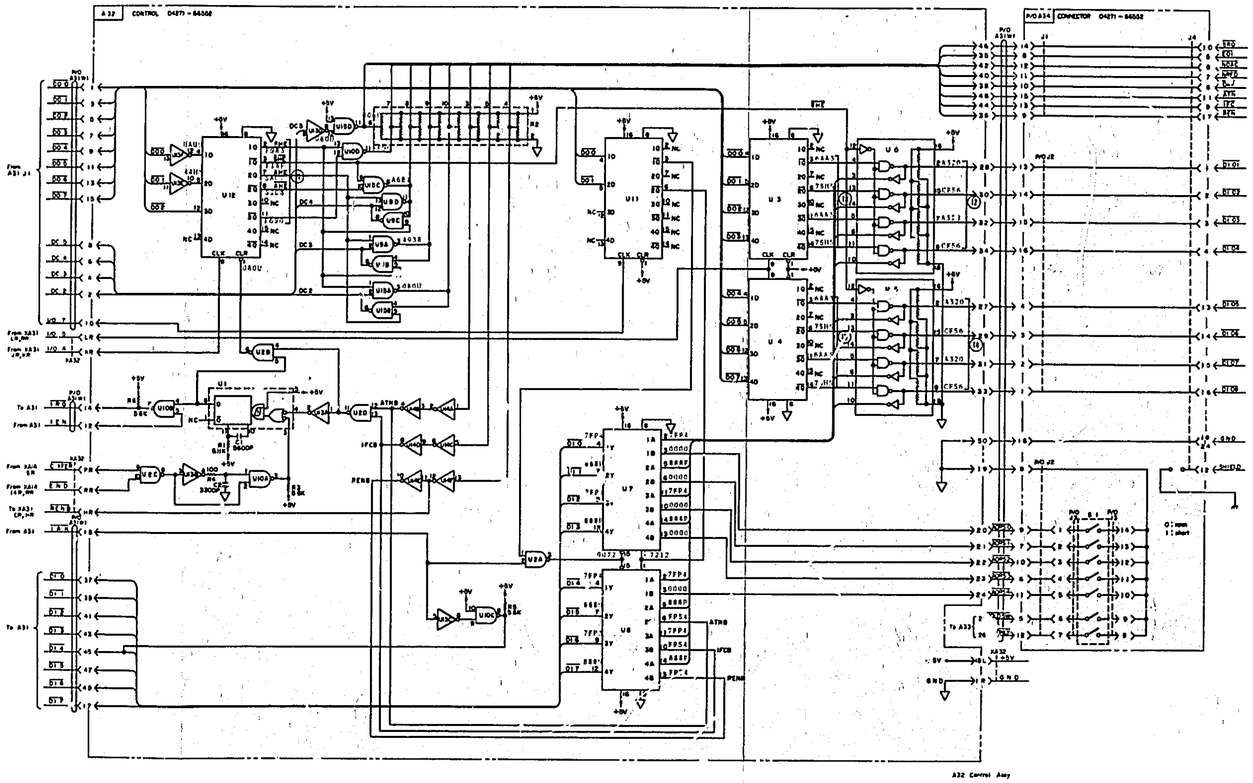


Figure 8-123. A32 HP-IB Control Board Assembly Schematic Diagram.

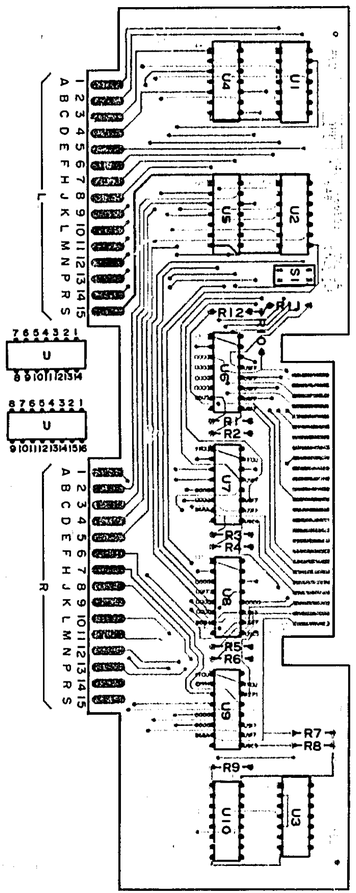


Figure 8-124. A33 HP-IB Data Board Assembly Component Locations.

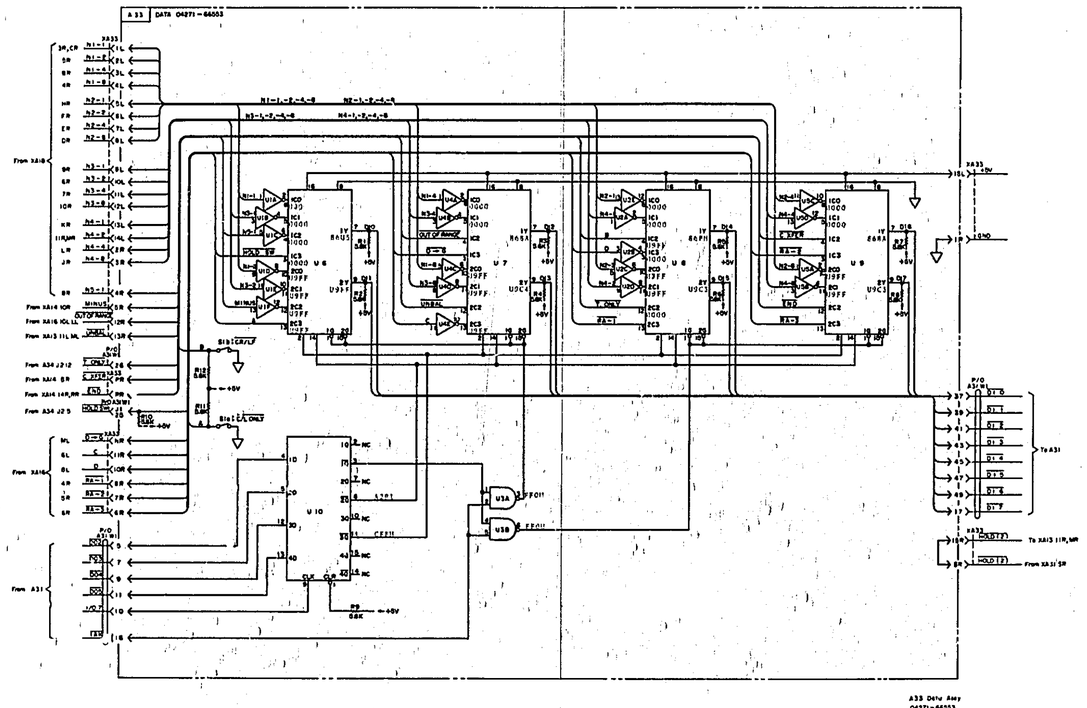


Figure 8-125. A33 HP-IB Data Board Assembly Schematic Diagram.

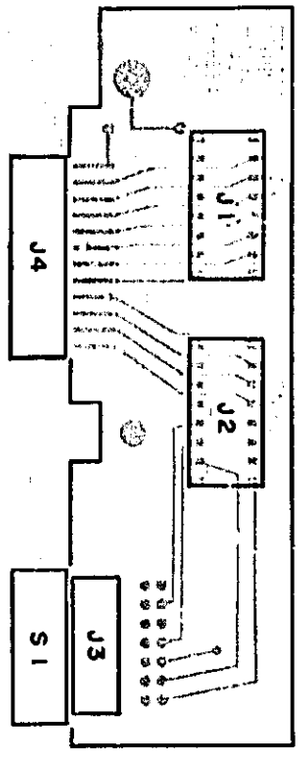


Figure 8-126. HP-IB Connector Board Assembly Component Locations.

MANUAL CHANGES

4271B

1MHz DIGITAL LCR METER

MANUAL IDENTIFICATION

Model Number: 4271B
Date Printed: APR. 1982
Part Number: 04271-90003

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:
Make all ERRATA corrections.
Make all appropriate serial number related changes indicated in the tables below.

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES	SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
ALL	1		
1838J00801 and above	2		
1838J01410 and above	3		
1838J01416 and above	4		

► NEW ITEM

ERRATA

►Page 3-20, Figure 3-10:
Change the signal names of pins 7 and 14 to N.C. (not connected).

Page 4-0, Table 4-1, Recommended Test Equipment:
Delete 15pF (PN 0160-2261) and 7500pF (PN 0160-2355) capacitors.

Add the following 1pF capacitor.

1pF ±0.25pF PN 0160-2236

Delete 1MΩ resistor (PN 0698-1055).

Page 5-16, paragraph 5-25, Dynamic Range Adjustment:
Change the part number for the 1pF capacitor in step c to read:

HP PN 0160-2236.

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

HEWLETT PACKARD

Printed in Japan

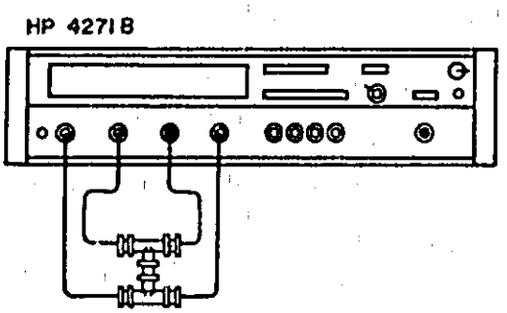
Page 5-22, paragraph 5-31, C-G OFFSET Counts Adjustment:
Change step d as follows.

... Then set C OFFSET ADJ fully ccw and read display ...

Page 5-23, paragraph 5-32, L-R OFFSET Counts Adjustment:

Change the part number of the BNC adapter (HP PN 1250-0081) to 1250-0080.

Change Figure 5-18 as shown below.



Pages 6-11, 6-13, 6-14, and 6-27, Table 6-3, Replaceable Parts:

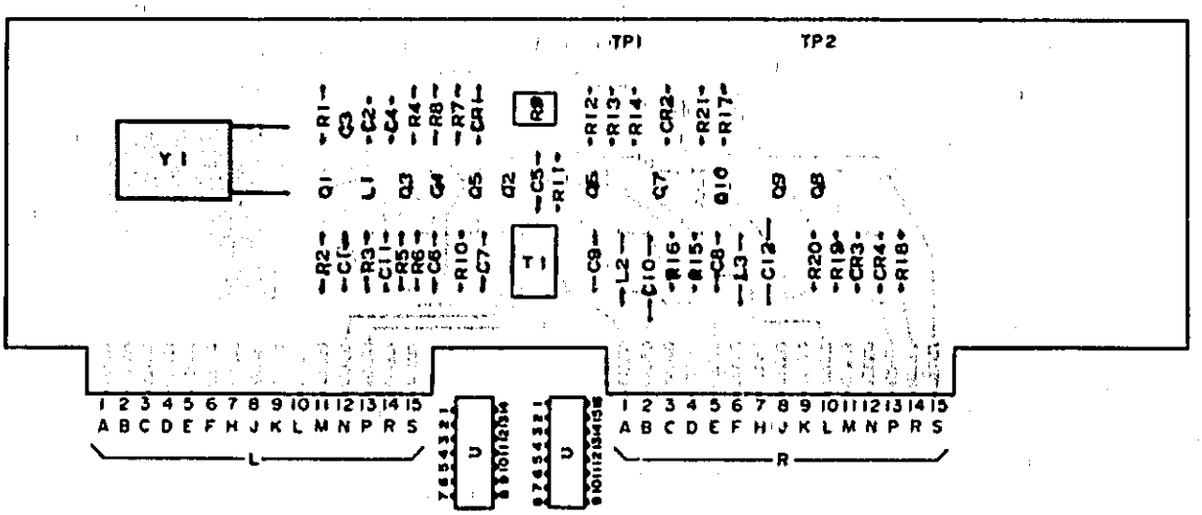
Refer to the parts change list.

Page 8-43, Figure 8-42, A3 Board Schematic Diagram:

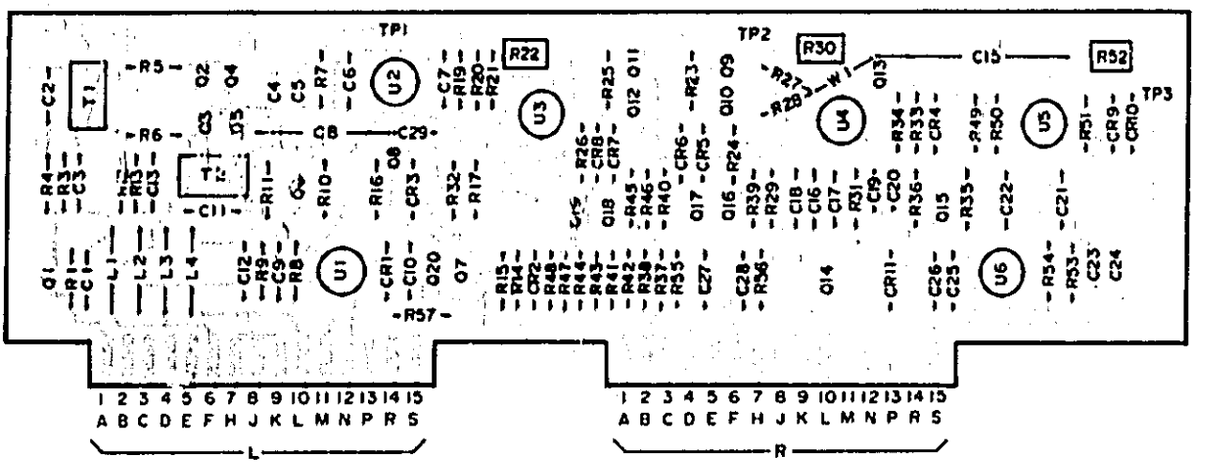
Change the value of A3R23 to 160K.

Page 8-45, Figure 8-45, A4 Board Component Locations:

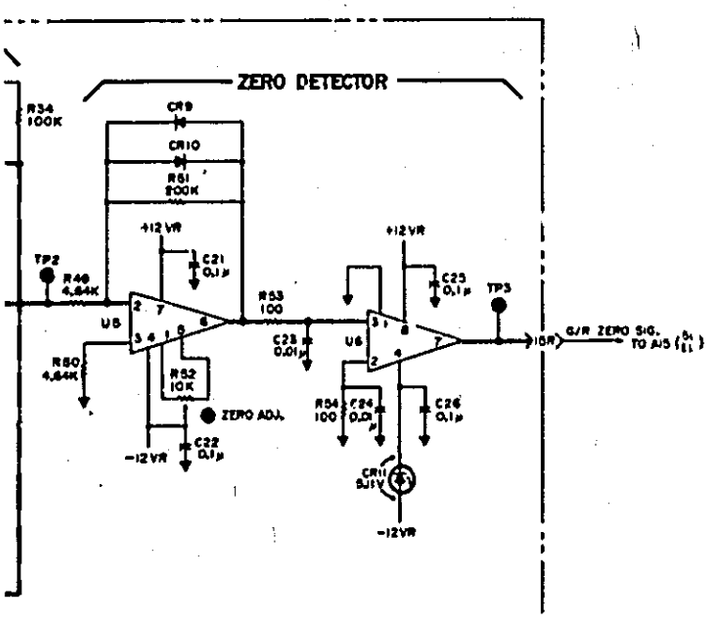
Change the diagram as follows.



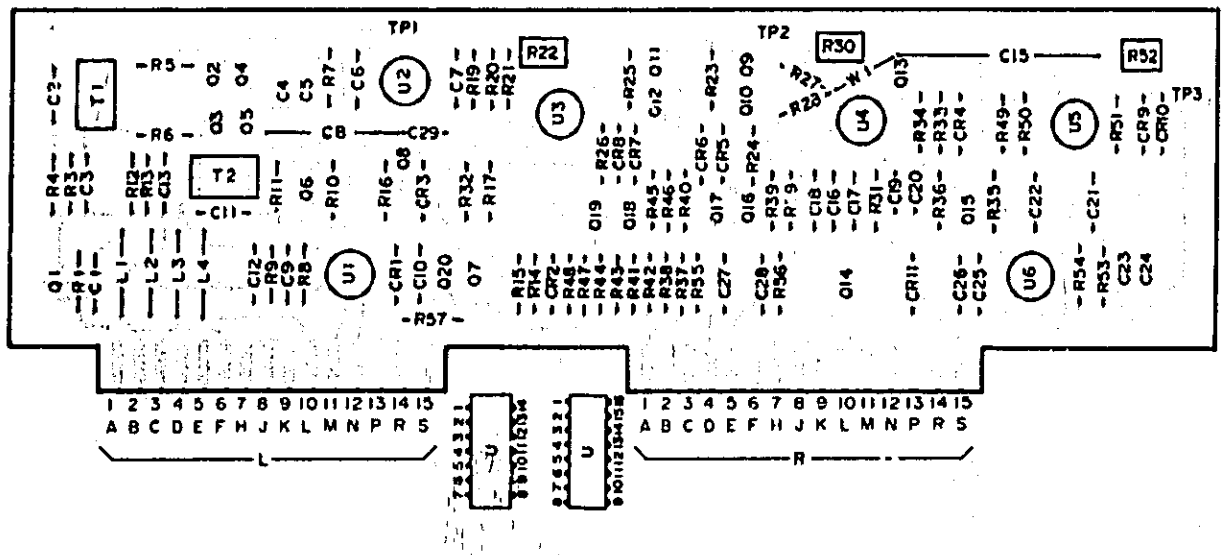
Page 8-49, Figure 8-53, A6 Board Component Locations:
Change the diagram as follows.



Page 8-49, Figure 8-54, A6 Board Schematic Diagram:
Change the schematic as shown below.

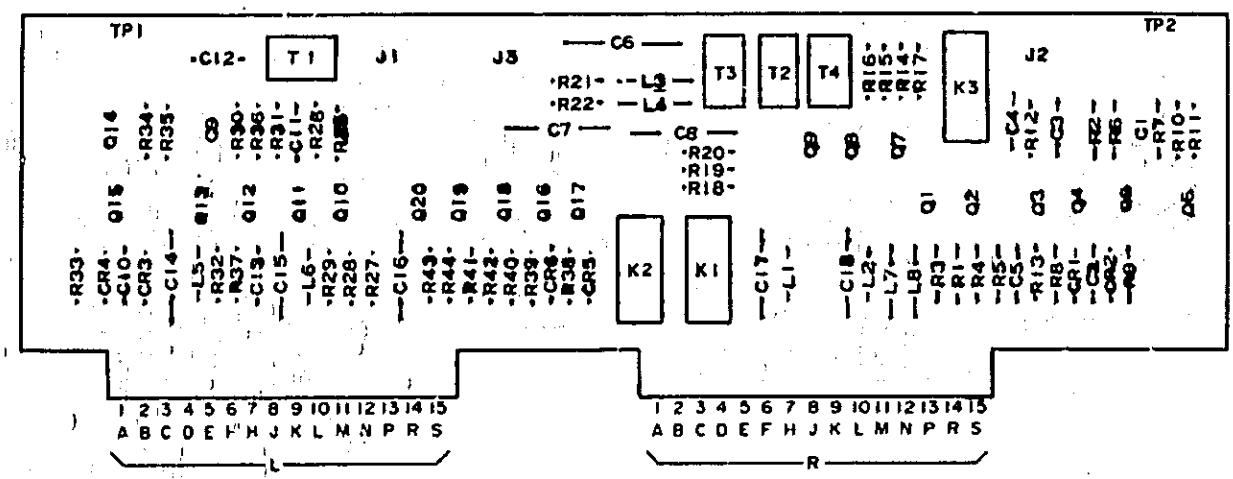


Page 8-51, Figure 8-57, A7 Board Component Locations:
Change the diagram as follows.

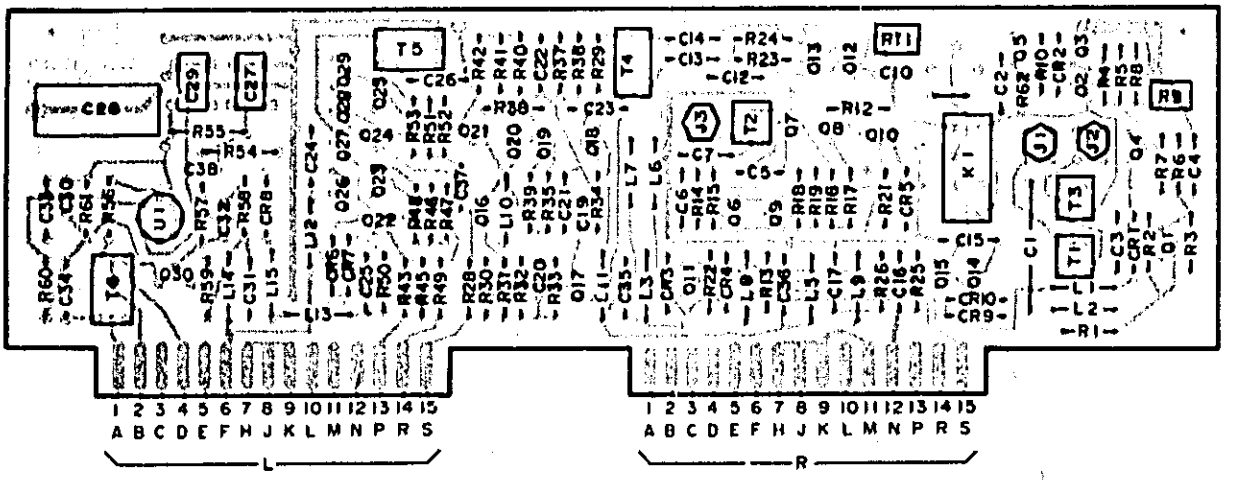


Page 8-53, Figure 8-62, A8 Board Schematic Diagram:
Change the value of A8C3 to 0.01μ.
Change the value of A8CR1 to 7.5V.
Change the value of A8R39 to 5.6K.
Change the value of A8R52 to 2K.
Change the value of A8R58 to 2.2K.
Change the value of A8R62 to 5.1K.

Page 8-55, Figure 8-65, A9 Board Component Locations:
Change the diagram as follows.



Page 8-57, Figure 8-69, A10 Board Component Locations:
Change the diagram as follows.

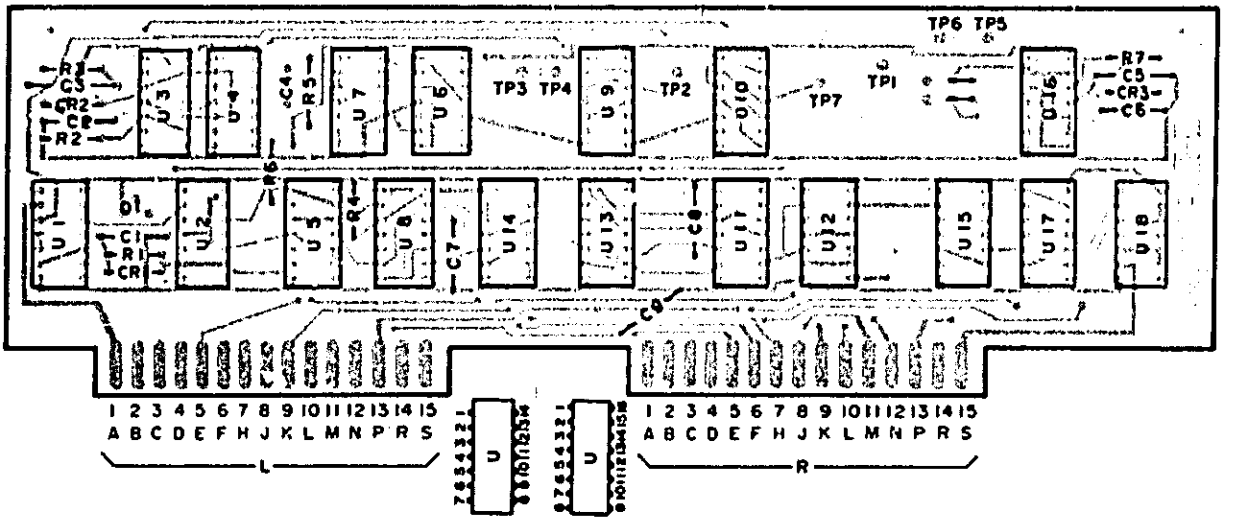


Page 8-57, Figure 8-70, A10 Board Schematic Diagram:
Change the value of A10C1 to 0.47µ.
Change the value of A10C4 to 1µ.
Change the value of A10C31 to 0.1µ

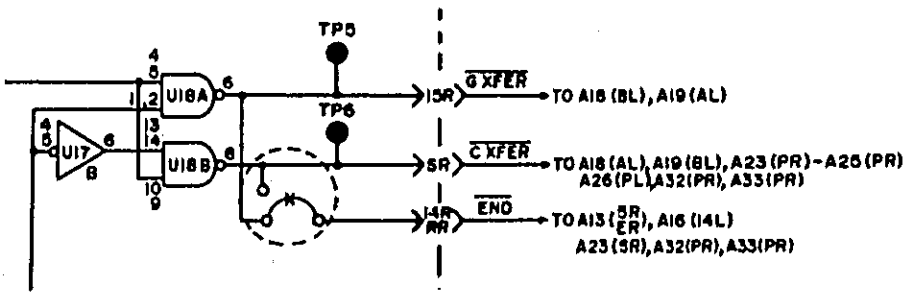
Page 8-59, Figure 8-74, A11 Board Schematic Diagram:
Change the values of A11C17 and C44 to 0.01µ.

Page 8-63, Figure 8-82, A13 Board Schematic Diagram:
Change the value of A13R5 to 8.2K.
Change the value of A13R23 to 270.
Change the value of A13R28 to 75.

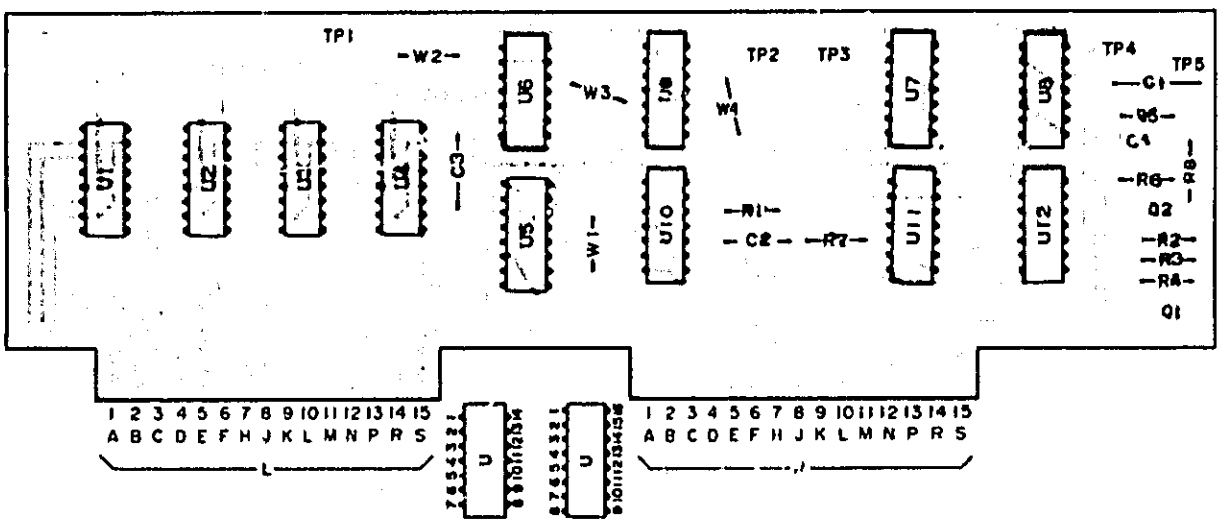
Page 8-65, Figure 8-85, A14 Board Component Locations:
Change the diagram as follows.



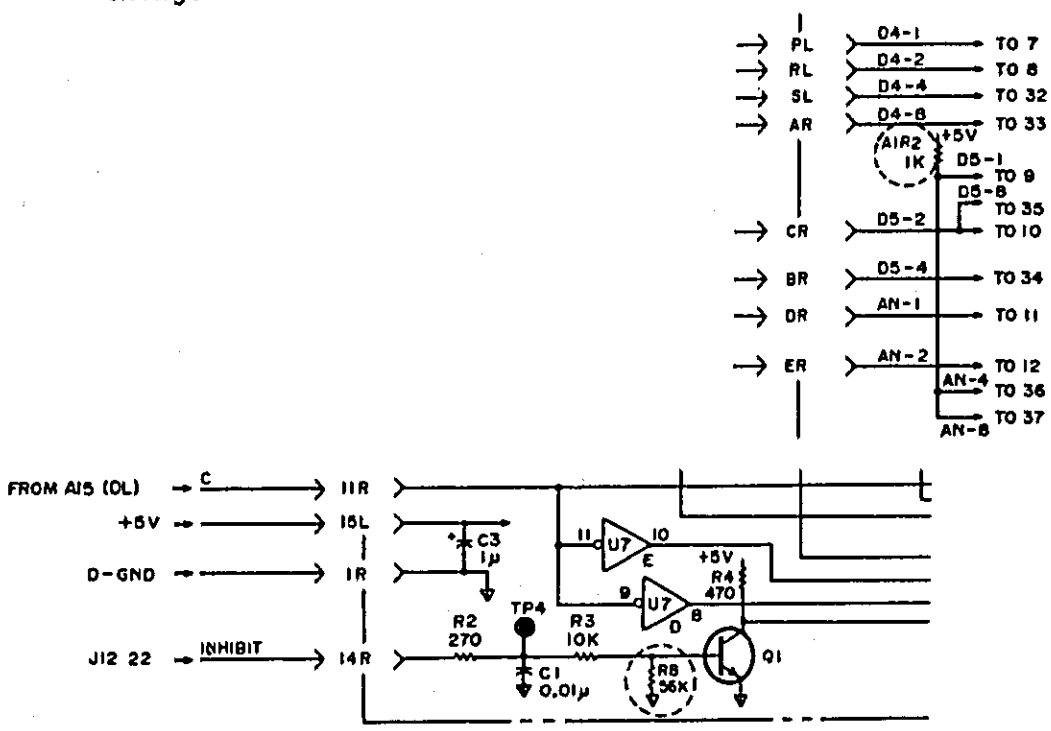
Page 8-65, Figure 8-86, A14 Board Schematic Diagram:
Change the value of A14C6 to 0.047μ.
Change the schematic as shown below.



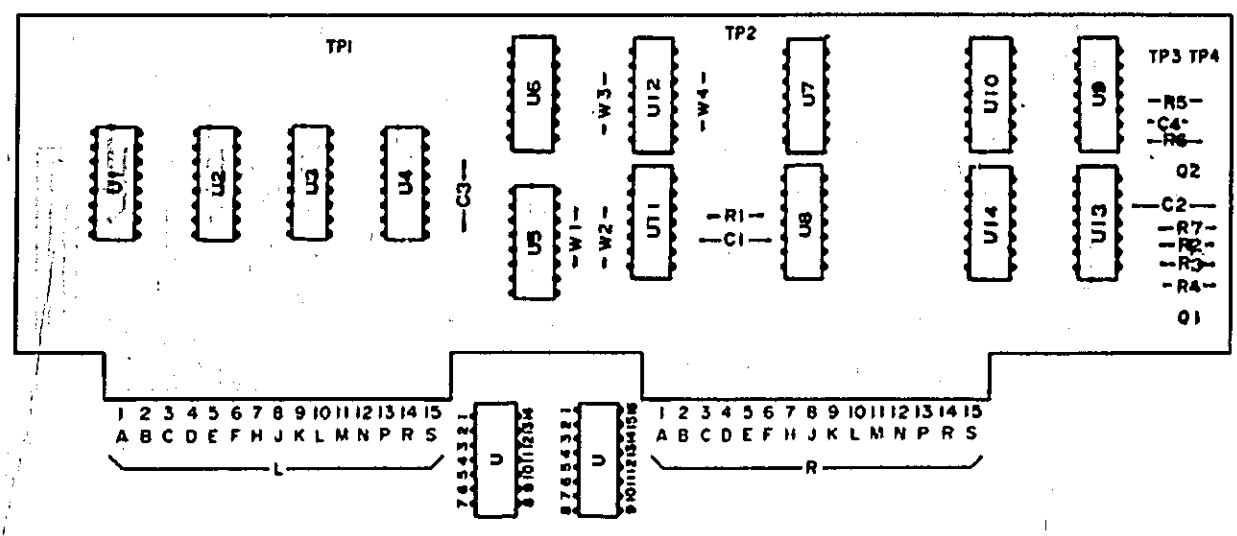
Page 8-79, Figure 8-109, A23 Board Component Locations:
Change the diagram as shown below.



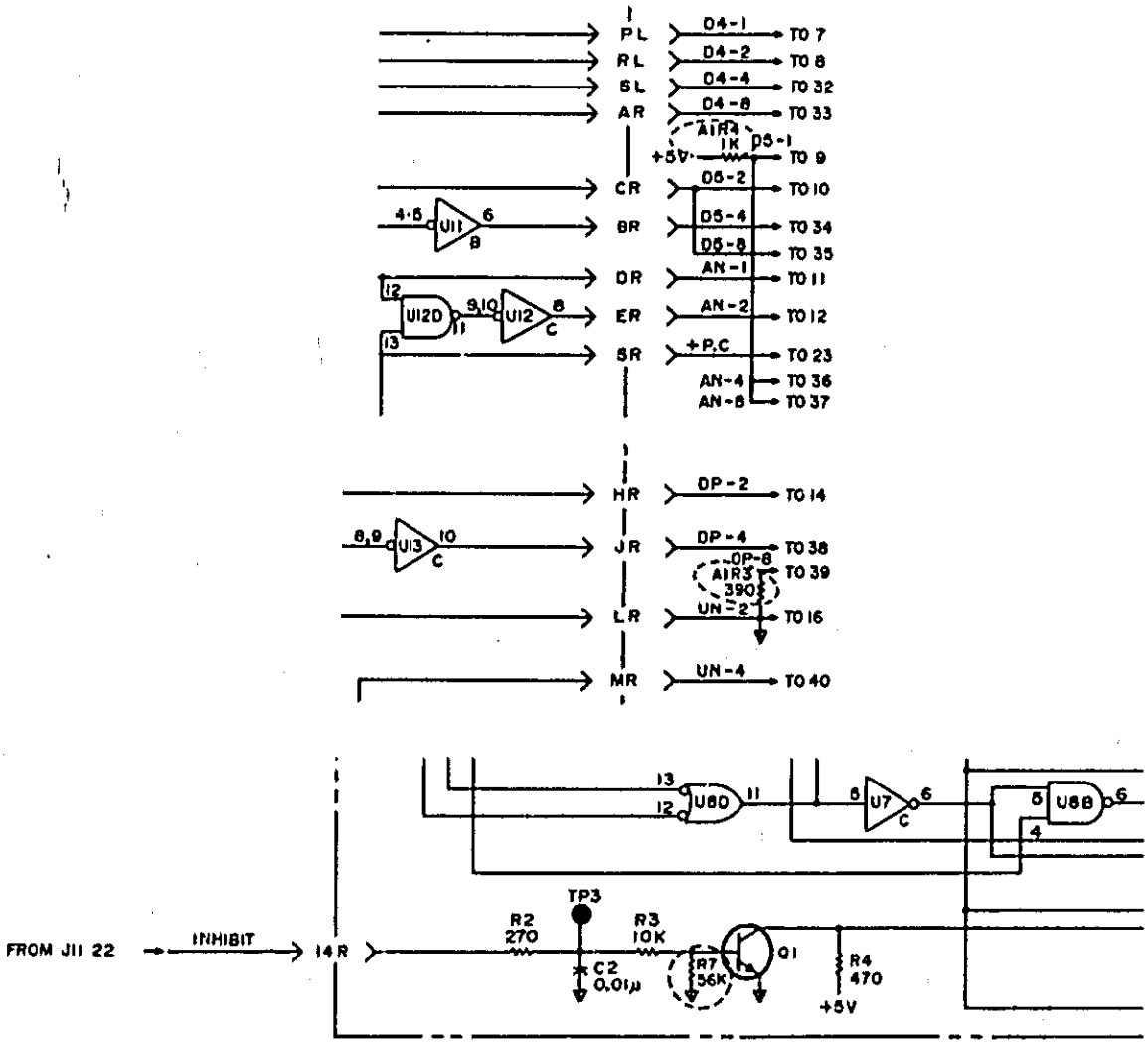
Page 8-79, Figure 8-110, A23 Board Schematic Diagram:
Change the schematic as shown below.



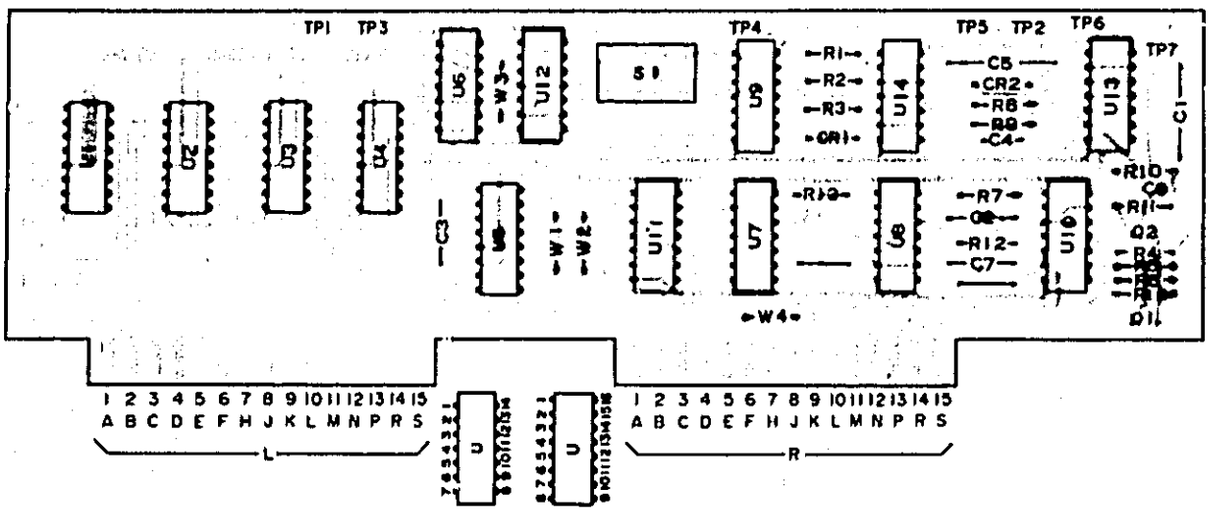
Page 8-81, Figure 8-112, A24 Board Component Locations:
Change the diagram as shown below.



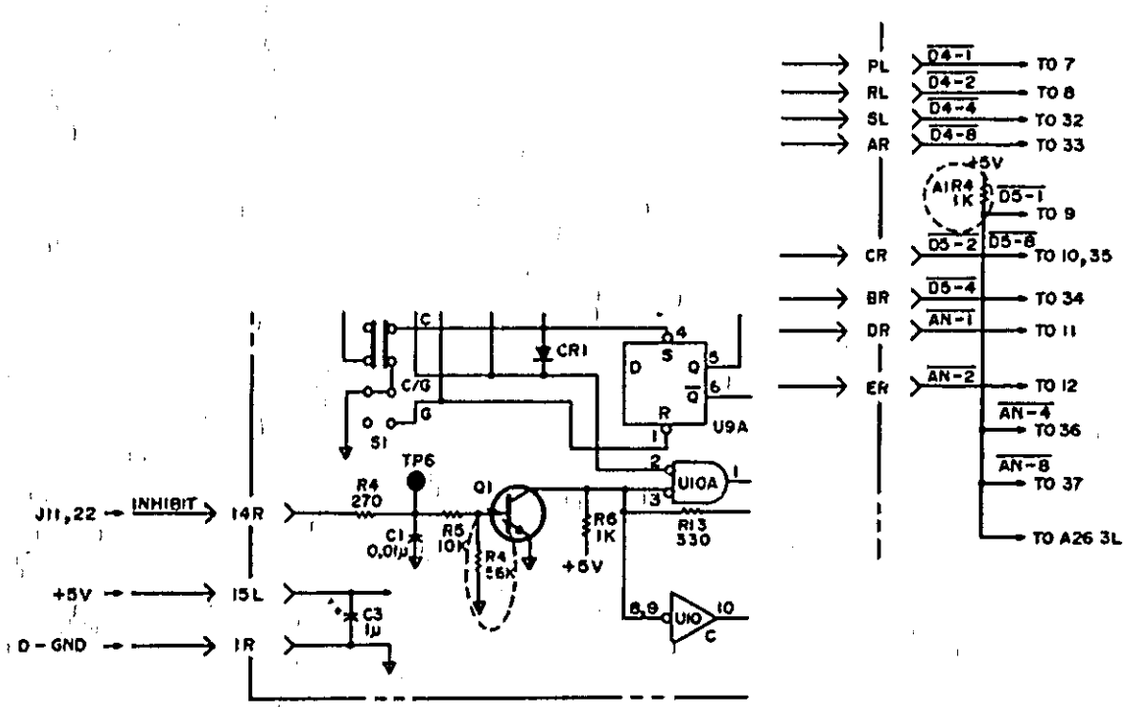
Page 8-81, Figure 8-113, A24 Board Schematic Diagram:
Change the schematic as shown below.



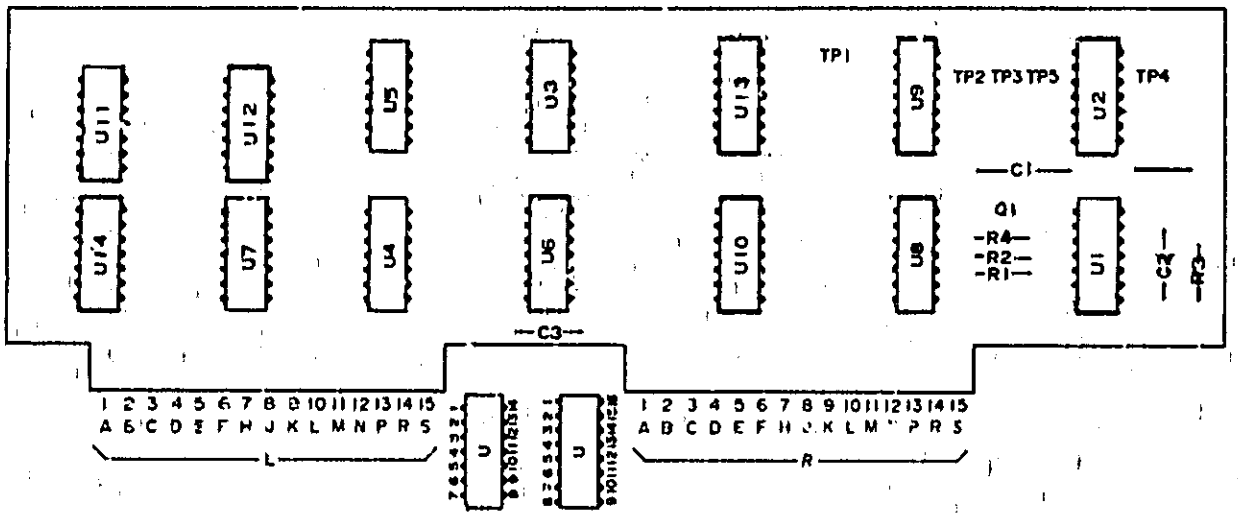
Page 8-83, Figure 8-115, A25 Board Component Locations:
Change the diagram as shown below.



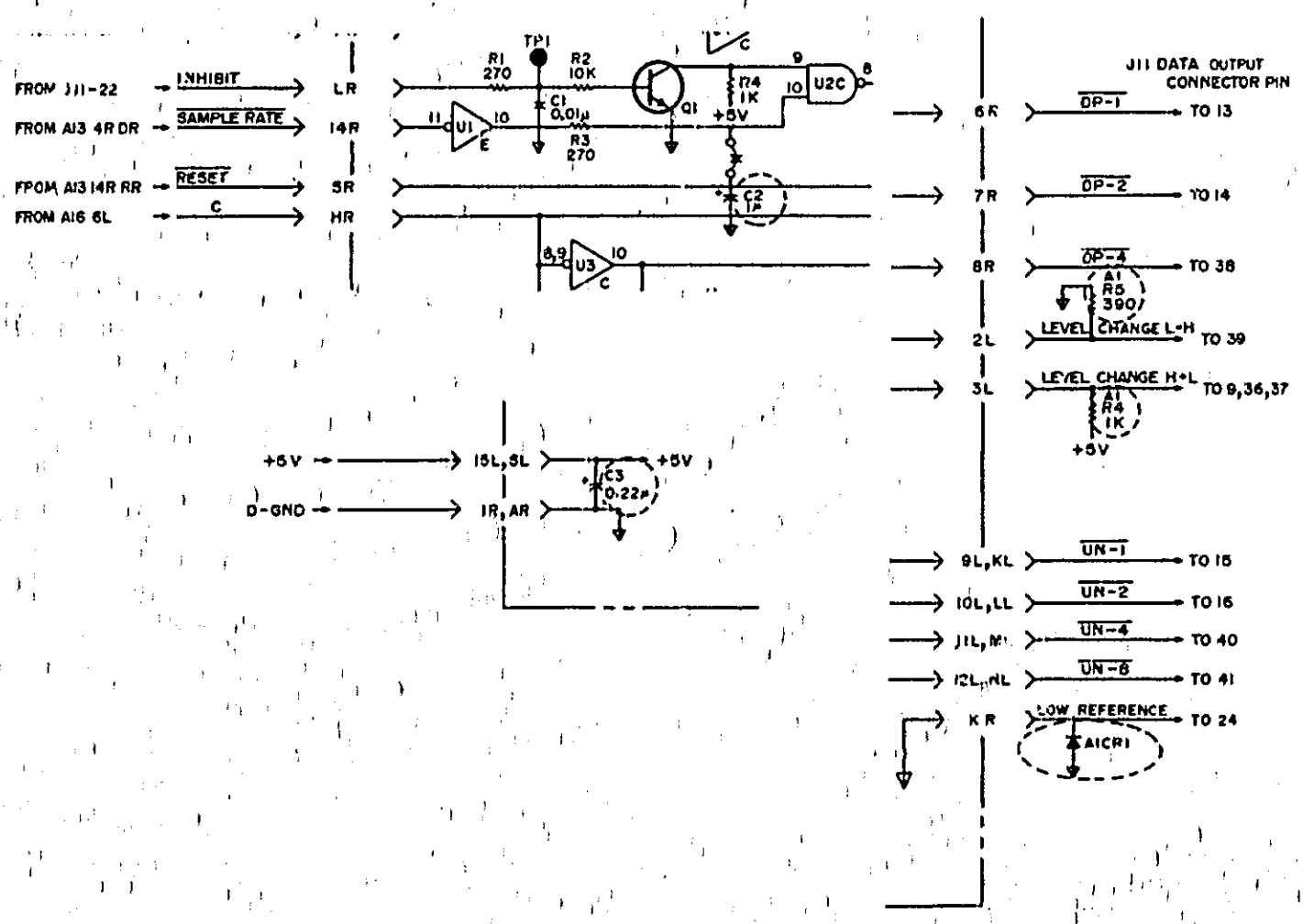
Page 8-83, Figure 8-116, A25 Board Schematic Diagram:
Change the value of A25C5 to 0.022µ.
Change the schematic as shown below.



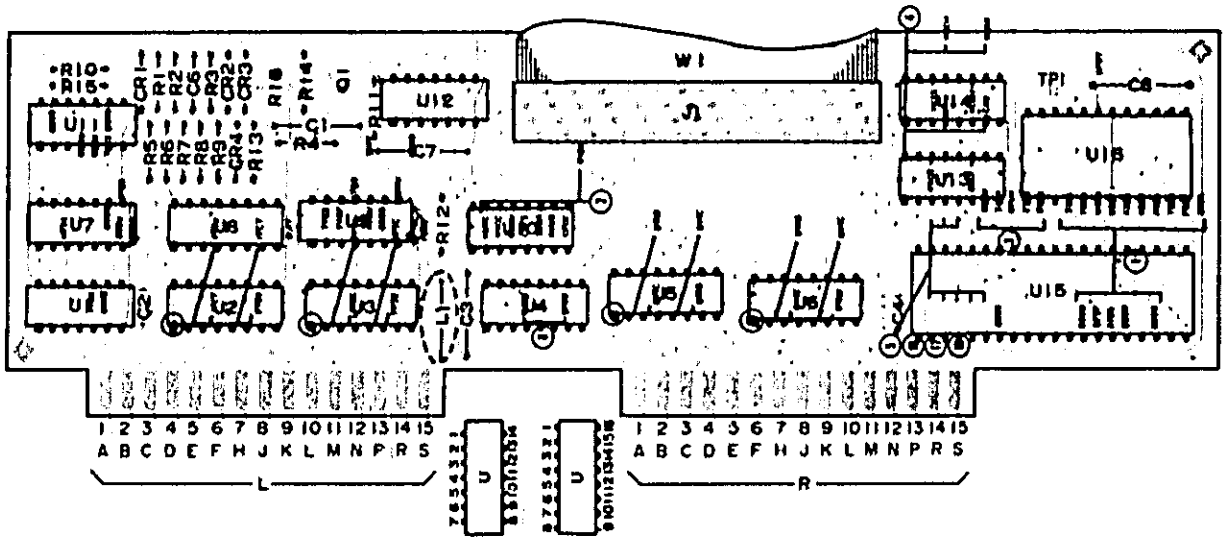
Page 8-85, Figure 8-118, A26 Board Component Locations:
Change the diagram as shown below.



Page 8-85, Figure 8-119, A26 Board Schematic Diagram:
Change the diagram as shown below.



Page 8-87, Figure 8-120, A31 Board Component Locations:
Change the diagram as shown below.



CHANGE 1

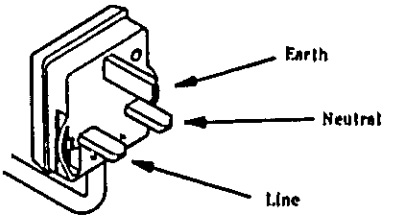
Page 1-9, Table 1-5, Accessories Available:
Delete the column for the 16021A.

Page 2-1, paragraph 2-12:
Change this paragraph as follows:

2-12. To preserve the protection feature when operating the instrument from a two contact outlet, use a three prong to two prong adapter (HP PN 1251-8196) and connect the green grounding tab on the adapter to power line ground.

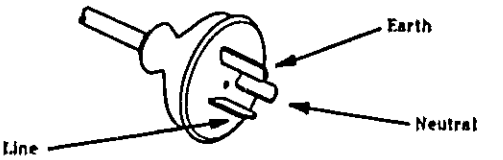
Page 2-3, Figure 2-2, Power Cables:
Change the figure as follows:

OPTION 900 United Kingdom



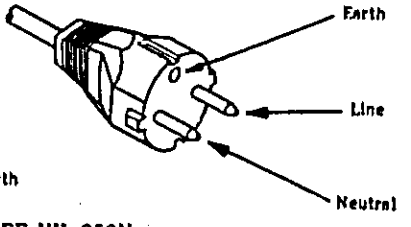
Plug : BS 1363A, 250V
Cable : HP 8120-1351

OPTION 901 Australia/New Zealand



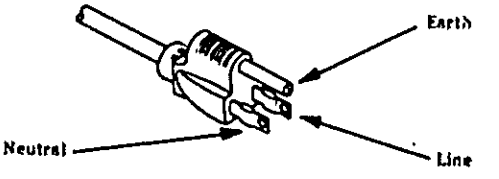
Plug : NZSS 198/AS C112, 250V
Cable : HP 8120-1369

OPTION 902 European Continent



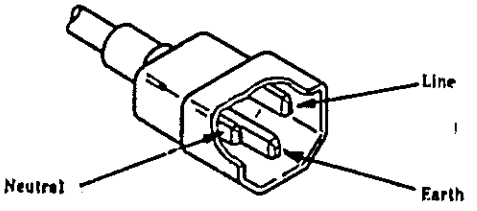
Plug : CEE-VII, 250V
Cable : HP 8120-1689

OPTION 903 U.S./Canada



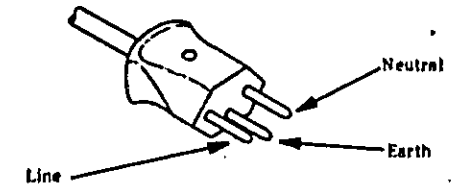
Plug : NEMA 5-15P, 125V, 15A
Cable : HP 8120-1378

OPTION 905* Any country



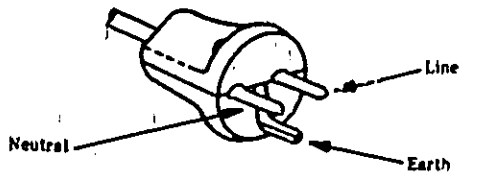
Plug : CEE 22-VI, 250V
Cable : HP 8120-1396

OPTION 906 Switzerland



Plug : SEV 1011.1959-24507 Type 12, 250V
Cable : HP 8120-2104

OPTION 912 Denmark



Plug : DHCR 107, 220V
Cable : HP 8120-2956

* Plug option 905 is frequently used for interconnecting system components and peripherals.

NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90 ° etc.)

Page 4-0, Table 4-1, Recommended Test Equipment:
Change ET-1467, recommended electronic tool, to PN 04271-65003.

Page 5-4, Table 5-2, Factory Selected Components (Sheet 2 of 2)

Component	Nominal Value Range
A12C9	HP PN 0160-2206, C:FXD 160pF
	HP PN 0140-0197, C:FXD 180pF
	HP PN 0140-0198, C:FXD 200pF

Page 5-19, paragraph 5-28, 10000 Counts Adjustment:
Change the part number of the Electronic Tool listed in EQUIPMENT to PN 04271-65003.

Change step a as follows.
a. Set 4271B and Electronic Tool (PN 04271-65003) as shown in Figure 5-17.

Change the title of Figure 5-17 to read.
HP 4271B Connections to Electronic Tool (PN 04271-65003)

Page 6-2, paragraph 6-10, SPARE PARTS KIT :
Delete paragraphs 6-10 and 6-11.

Pages 6-3 to 6-31, Table 6-3, Replaceable Parts:
Refer to the parts change list.

Page 8-43, Figure 8-42, A3 Board Schematic Diagram:
Change the value of A3C6 to 100p.

Page 8-45, Figure 8-46, A4 Board Schematic Diagram:
Change the value of A4CR1 to 6.8V.

Page 8-49, Figure 8-54, A6 board Schematic diagram:
Change the values of A6C4, C19 and C20 to 0.047µ.

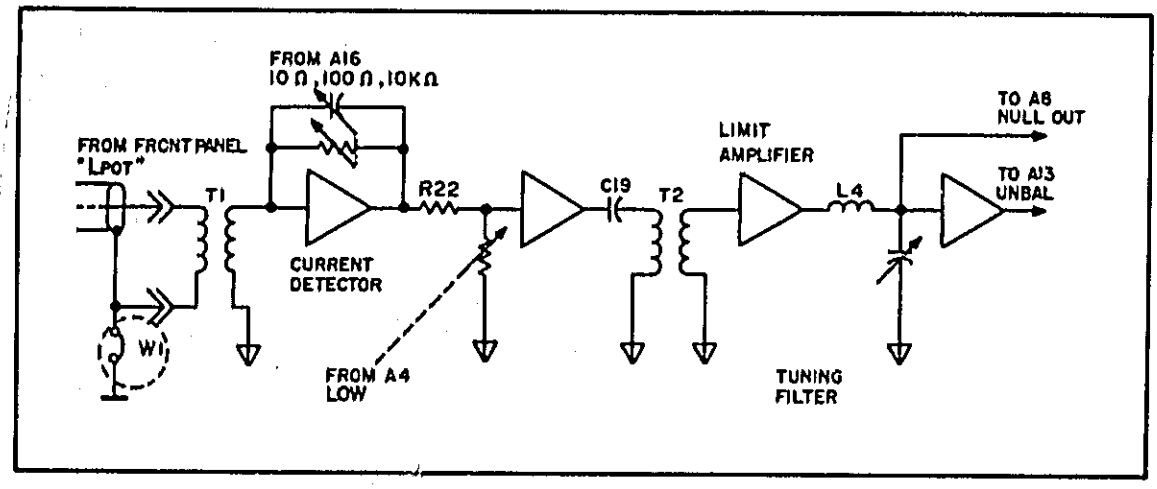
Page 8-51, Figure 8-58, A7 Board Schematic Diagram:
Change the values of A7C4, C19 and C20 to 0.047µ.

Page 8-61, Figure 8-78, A12 Board Schematic Diagram:
Change the value of A12C9* to 200p.
Change the value of A12R42* to 15.4K.
Change the value of A12R56* to 10K.

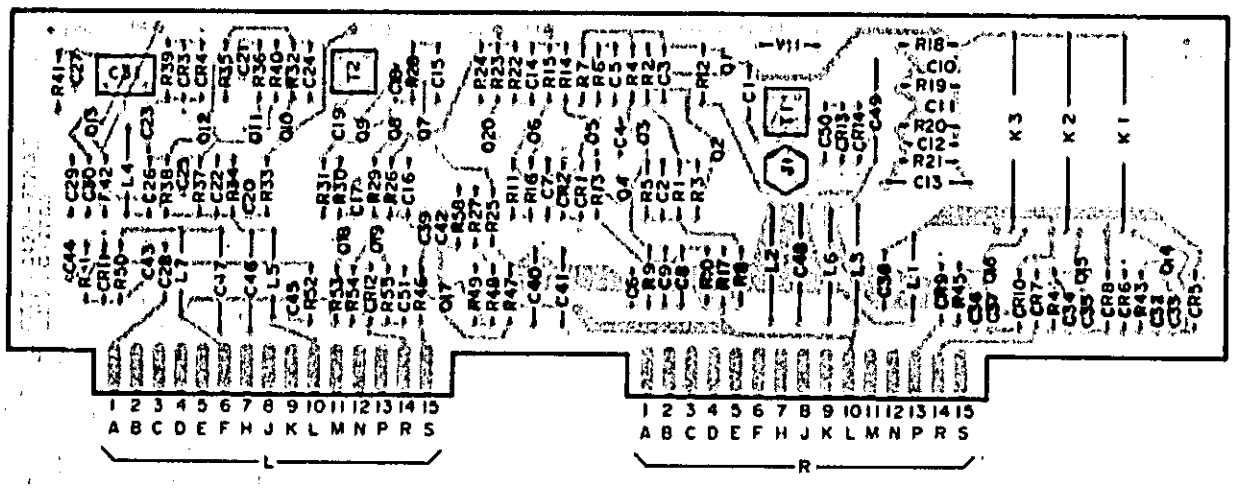
CHANGE 2

Pages 6-17 and 6-23, Table 6-3, Replaceable Parts:
Refer to the parts change list.

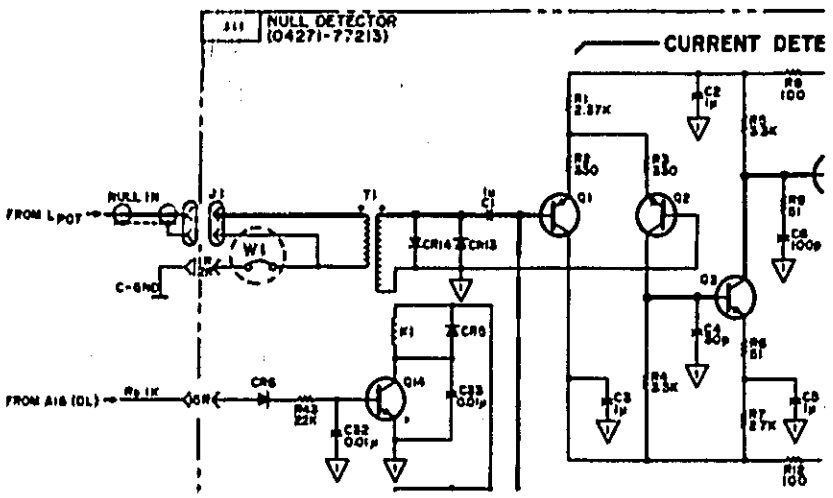
Page 8-58, Figure 8-72, Block Diagram of All Board:
Change the schematic as follows.



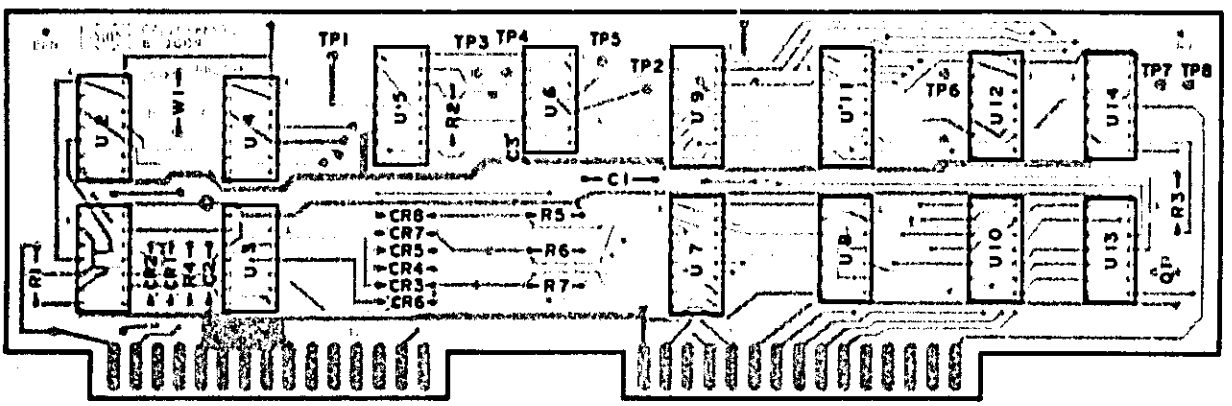
Pages 8-59, Figure 8-73, All Board Component Locations:
Change the diagram as follows.



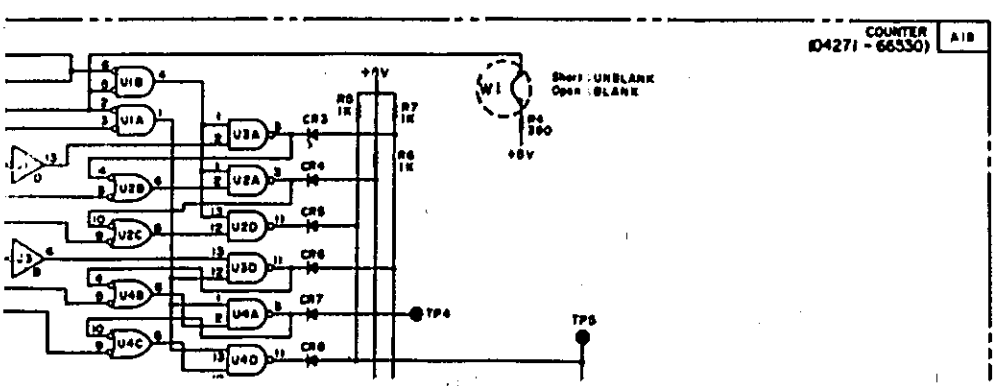
Page 8-59, Figure 8-74, A11 Board Schematic Diagram:
Designate the unmarked jumper W1 as shown below.



Page 8-73, Figure 8-101, A18 Board Component Locations:
Change the diagram as follows.



Page 8-73, Figure 8-102, A18 Board Schematic diagram:
Designate the unmarked jumper W1 as shown below.



CHANGE 3

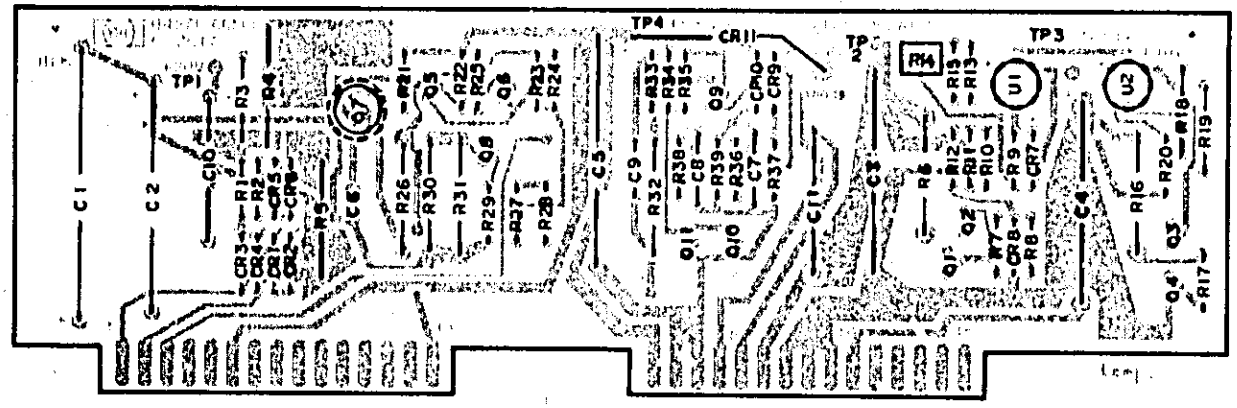
Pages 6-19 amd 6-20, Table 6-3, Replaceable Parts:
Refer to the parts change list.

Page 8-63, Figure 8-82, A13 Board Schematic Diagram:
Change the value of A13C4 to 33µ.
Change the value of A13C5 to 22µ.
Change the value of A13R20 to 30.1K.

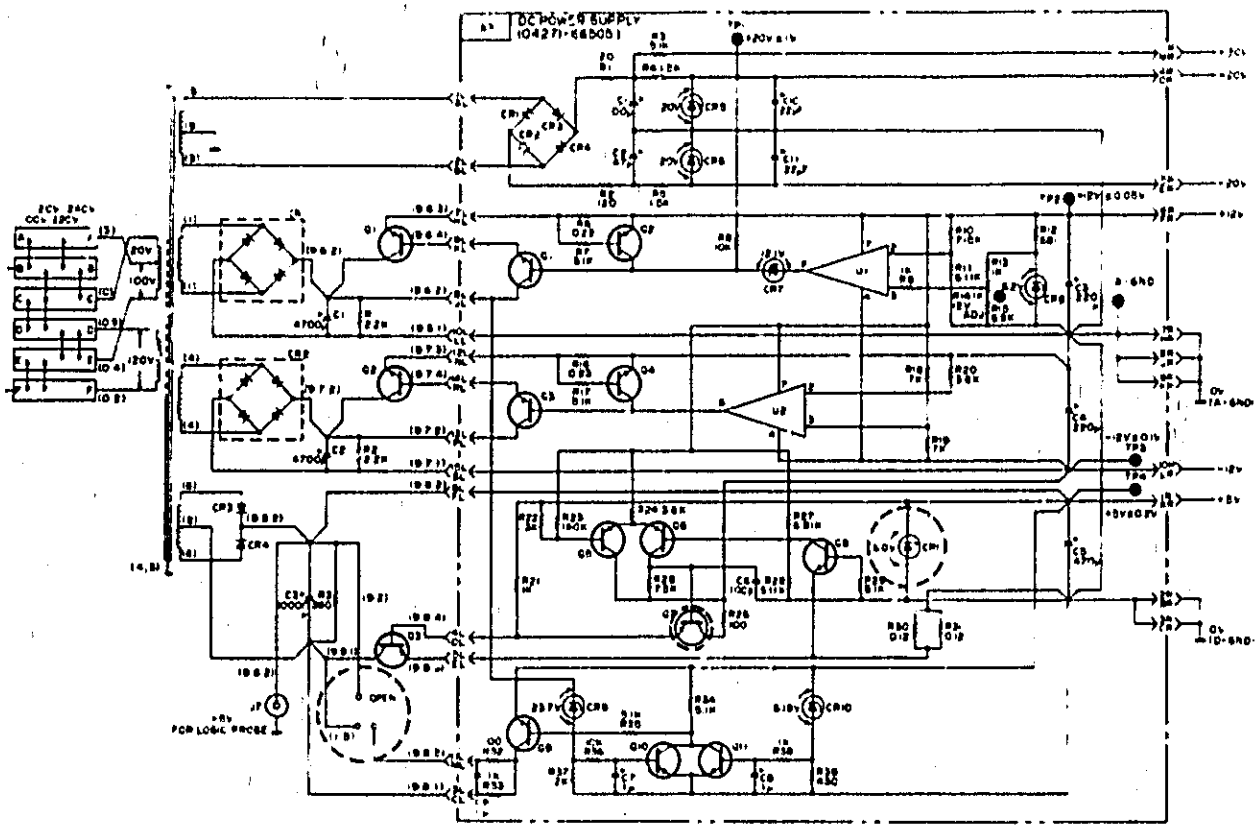
CHANGE 4

Pages 6-4 and 6-30, Table 6-3, Replaceable Parts:
Refer to the parts change list.

Page 8-43, Figure 8-42, A3 Board Component Locations:
Change the diagram as follows.



Page 8-43, Figure 8-42, A3 Board Schematic Diagram:
Change the schematic as follows.



Change the part numbers and descriptions of the replaceable parts in accordance with the table below:

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
ERRATA	6-11	C	A8R39	0683-5625	RESISTOR 5.6K 5% .25W FC TC=-400/+700
		C	A8R52	0683-2025	RESISTOR 2K 5% .25W FC TC=-400/+700
		C	A8R58	0683-2225	RESISTOR 2.2K 5% .25W FC TC=-400/+700
		C	A8R62	0683-5125	RESISTOR 5.1K 5% .25W FC TC=-400/+700
	6-13	C	A10C4	0160-0127	CAPACITOR-FXD 1µF ±20% 25VDC CER
	6-14	C	A10K1	0490-0875	RELAY 2C 12VDC-COIL 2A 30VDC
	6-27	A	A24R7	0683-5635	RESISTOR 56K 5% .25W FC TC=-400/+800
		A	A25R14	0683-5635	RESISTOR 56K 5% .25W FC TC=-400/+800
1	6-4	C	A3C6	0160-2204	CAPACITOR-FXD 100pF+5% 300VDC MICA
		C	A3C10	No change	CAPACITOR-FXD 22µF 63V
		C	A3C11	No change	CAPACITOR-FXD 22µF 63V
		C	A4C1	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4C5	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-5	C	A4C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4C8	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4CR1	1902-1382	DIODE-ZNR 6.8V 5% PD=.4W
		C	A4Q1	5080-3835	No change
		C	A5C5	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C14	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C19	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C20	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C21	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-6	C	A5R35	0698-3154	No change
		C	A6C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C4	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A6C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C9	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C11	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C13	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	▶ A6C15	0160-6406	CAPACITOR-FXD .068µF
		C	A6C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C18	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
1	6-6	C	A6C19	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A6C20	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A6C21	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-7	C	A6C22	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C26	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C27	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A6Q8	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
		▶ C	A6Q13	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
	6-8	C	A7C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C4	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A7C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C9	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C11	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C13	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A7C15	0160-6406	CAPACITOR-FXD .068µF
		C	A7C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C18	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C19	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A7C20	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A7C21	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C22	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C26	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C27	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-9	▶ C	A7Q8	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
		▶ C	A7Q13	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
	6-10	C	A8C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C8	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C27	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C29	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C30	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C40	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C41	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C43	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C44	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8Q1	5080-3830	No change
		C	A8Q2	5080-3830	No change
		C	A8Q3	5080-3830	No change

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
1	6-10	C	A8Q4	5080-3830	No change
		C	A8Q9	5080-3830	No change
		C	A8Q11	5080-3830	No change
	6-12	C	A9C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A9C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-13	C	A10C3	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A10C10	0160-4796	CAPACITOR-FXD 3.9pF ±0.25pF
		C	A10C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C13	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C15	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C23	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C24	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C31	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-14	C	A10Q5	5080-3830	No change
		C	A10Q10	5080-3830	No change
		C	A10Q12	5080-3835	No change
		C	A10Q14	5080-3835	No change
	6-15	C	A11C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C15	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C22	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C24	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-16	C	A11C26	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C29	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C30	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C51	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-17	C	A12C9*	0140-0198	CAPACITOR-FXD 200pF ±5% 300VDC MICA
	6-19	C	A12R42*	0698-3540	RESISTOR 15.4K 1% .125W F TC=0±100
		C	A12R56*	0757-0442	RESISTOR 10K 1% .125W F TC=0±100
		C	A13C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A13C11	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A13C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-20	C	A14C6	0160-4834	CAPACITOR-FXD .047µF ±10% 50VDC CER
		▶ C	A14C9	0160-4574	CAPACITOR-FXD 1000pF
	6-23	C	A18C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A18C3	0160-4574	CAPACITOR-FXD 1000pF

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
	6-26	C C C	A21U4 A21U5 A21U6	1820-1411 1820-1411 1820-1411	IC LCH TTL LS D-TYPE 4-BIT IC LCH TTL LS D-TYPE 4-BIT IC LCH TTL LS D-TYPE 4-BIT
	6-28	C	A31C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-29	C C	A34J1 A34J2	1200-0607 1200-0607	No change No change
1	6-30	C	J5	1510-0310	No change
2	6-17	A	A11W1	8159-0005	RESISTOR-ZERO OHMS 22 AWG LEAD DIA
	6-23	A	A18W1	8159-0005	RESISTOR-ZERO OHMS 22 AWG LEAD DIA
3	6-19	C C	A13C4 A13C5	0180-0229 0180-0228	CAPACITOR-FXD 33µF CAPACITOR-FXD 22uF
	6-20	C C	A13R20 A13U5	0757-0453 1820-0371	RESISTOR 30.1K 1% .125W F TC=0±100 IC GATE TTL H NAND TPL 3-INP
4	6-4	A	A3CR11	1902-0552	DIODE-ZNR 6.0V
	6-30	D	CR5	1884-0005	DIODE: THYRISTOR (SCR) 50V

▶: New item C: Change D: Delete A: Add

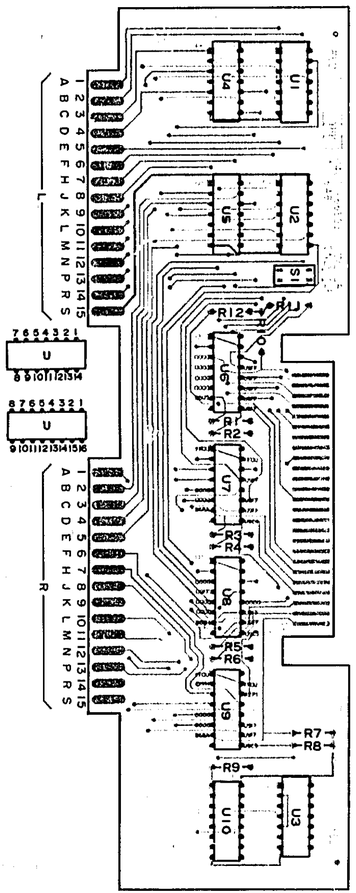


Figure 8-124. A33 HP-IB Data Board Assembly Component Locations.

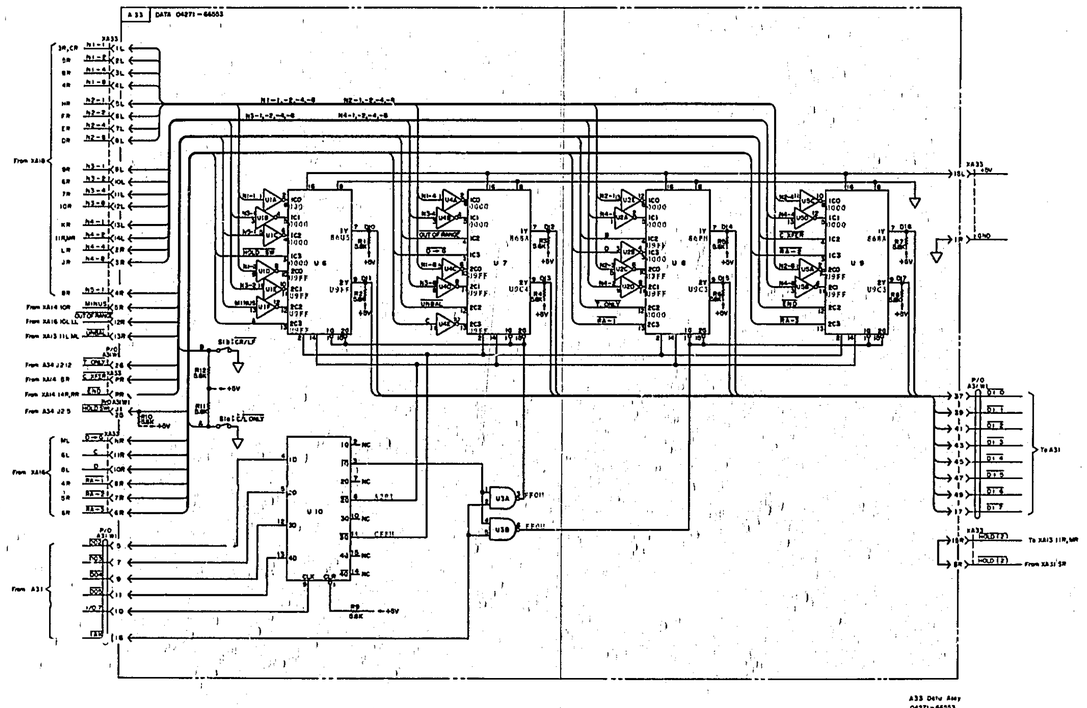


Figure 8-125. A33 HP-IB Data Board Assembly Schematic Diagram.

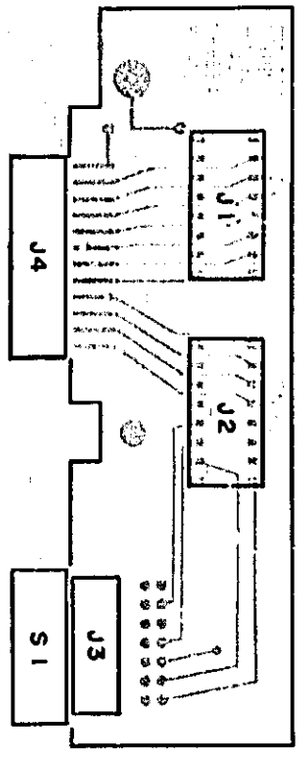


Figure 8-126. HP-IB Connector Board Assembly Component Locations.

MANUAL CHANGES

4271B

1MHz DIGITAL LCR METER

MANUAL IDENTIFICATION

Model Number: 4271B
Date Printed: APR. 1982
Part Number: 04271-90003

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:
Make all ERRATA corrections.
Make all appropriate serial number related changes indicated in the tables below.

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES	SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
ALL	1		
1838J00801 and above	2		
1838J01410 and above	3		
1838J01416 and above	4		

► NEW ITEM

ERRATA

►Page 3-20, Figure 3-10:
Change the signal names of pins 7 and 14 to N.C. (not connected).

Page 4-0, Table 4-1, Recommended Test Equipment:
Delete 15pF (PN 0160-2261) and 7500pF (PN 0160-2355) capacitors.

Add the following 1pF capacitor.

1pF ±0.25pF PN 0160-2236

Delete 1MΩ resistor (PN 0698-1055).

Page 5-16, paragraph 5-25, Dynamic Range Adjustment:
Change the part number for the 1pF capacitor in step c to read:

HP PN 0160-2236.

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

HEWLETT PACKARD

Printed in Japan

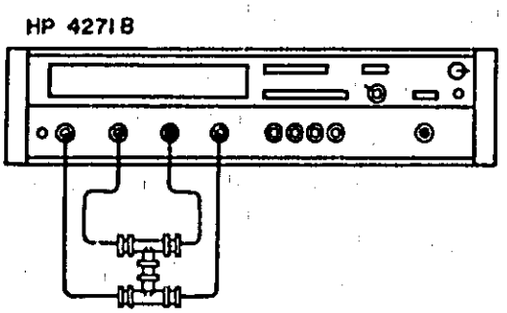
Page 5-22, paragraph 5-31, C-G OFFSET Counts Adjustment:
Change step d as follows.

... Then set C OFFSET ADJ fully ccw and read display ...

Page 5-23, paragraph 5-32, L-R OFFSET Counts Adjustment:

Change the part number of the BNC adapter (HP PN 1250-0081) to 1250-0080.

Change Figure 5-18 as shown below.



Pages 6-11, 6-13, 6-14, and 6-27, Table 6-3, Replaceable Parts:

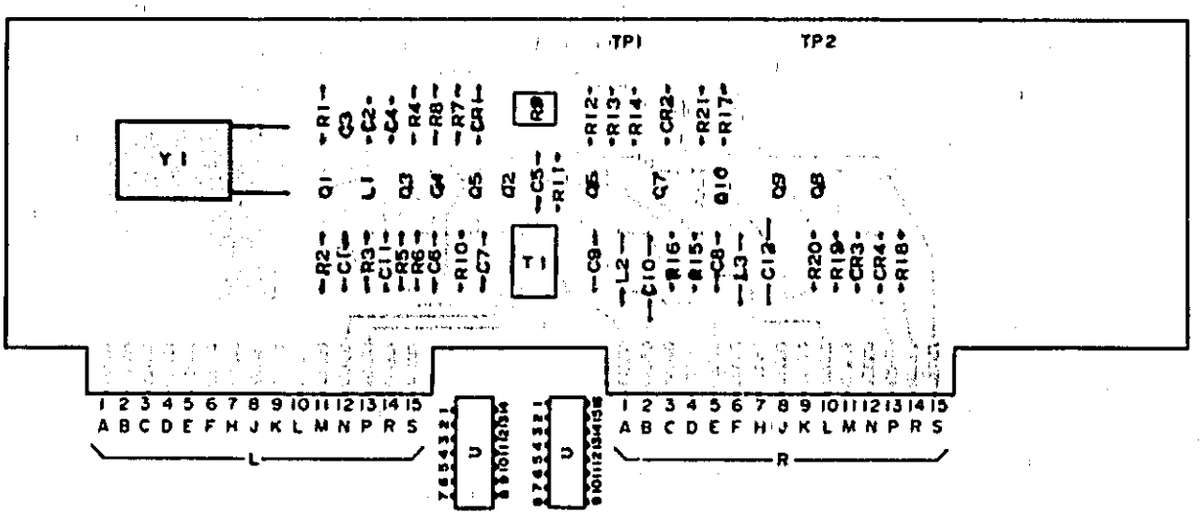
Refer to the parts change list.

Page 8-43, Figure 8-42, A3 Board Schematic Diagram:

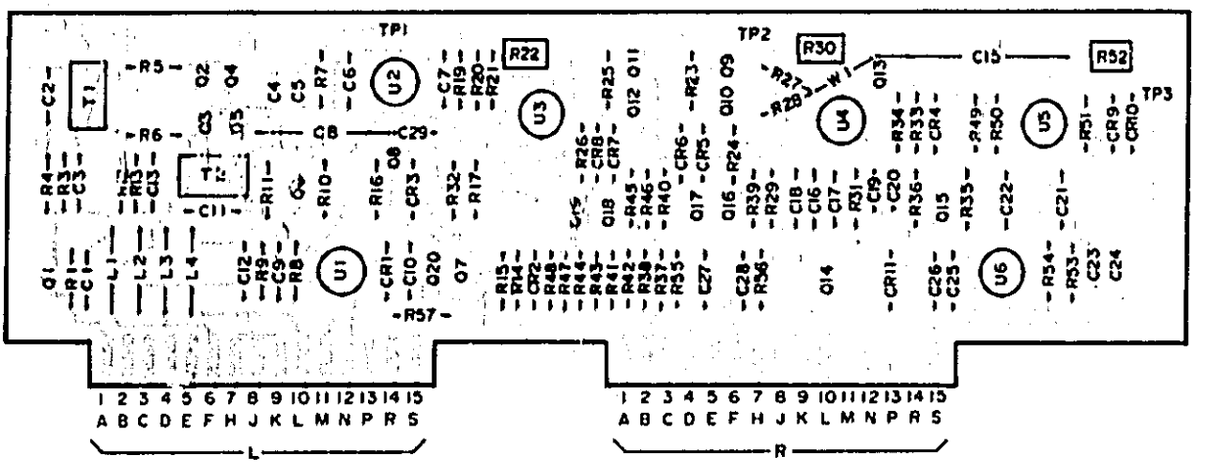
Change the value of A3R23 to 160K.

Page 8-45, Figure 8-45, A4 Board Component Locations:

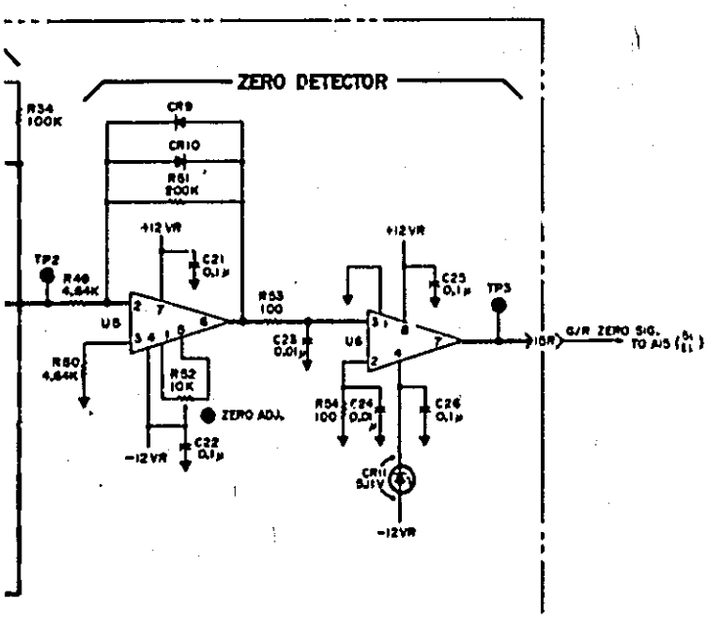
Change the diagram as follows.



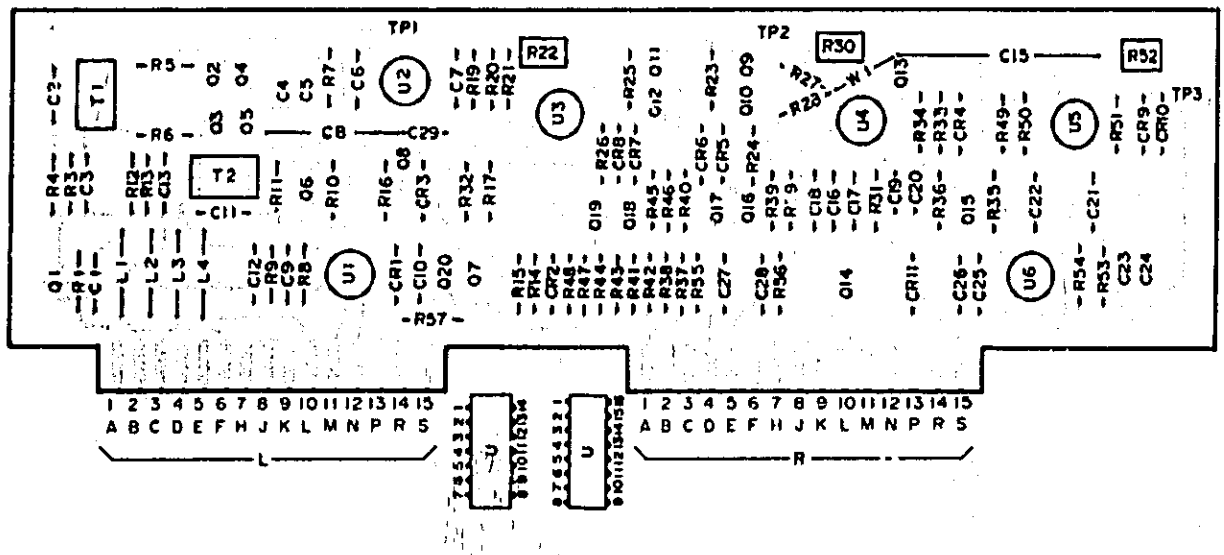
Page 8-49, Figure 8-53, A6 Board Component Locations:
Change the diagram as follows.



Page 8-49, Figure 8-54, A6 Board Schematic Diagram:
Change the schematic as shown below.

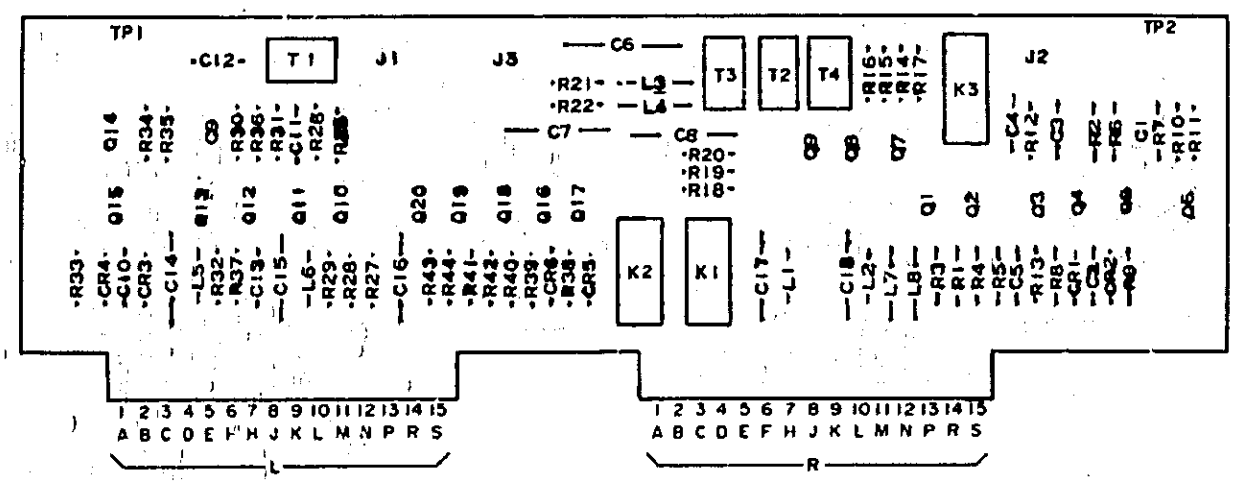


Page 8-51, Figure 8-57, A7 Board Component Locations:
Change the diagram as follows.

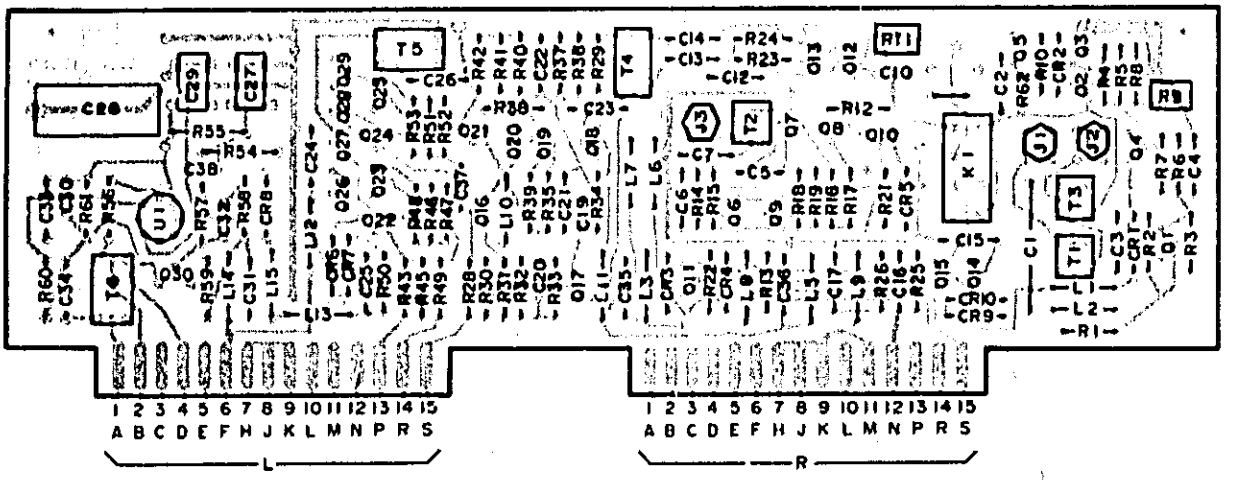


Page 8-53, Figure 8-62, A8 Board Schematic Diagram:
Change the value of A8C3 to 0.01μ.
Change the value of A8CR1 to 7.5V.
Change the value of A8R39 to 5.6K.
Change the value of A8R52 to 2K.
Change the value of A8R58 to 2.2K.
Change the value of A8R62 to 5.1K.

Page 8-55, Figure 8-65, A9 Board Component Locations:
Change the diagram as follows.



Page 8-57, Figure 8-69, A10 Board Component Locations:
Change the diagram as follows.

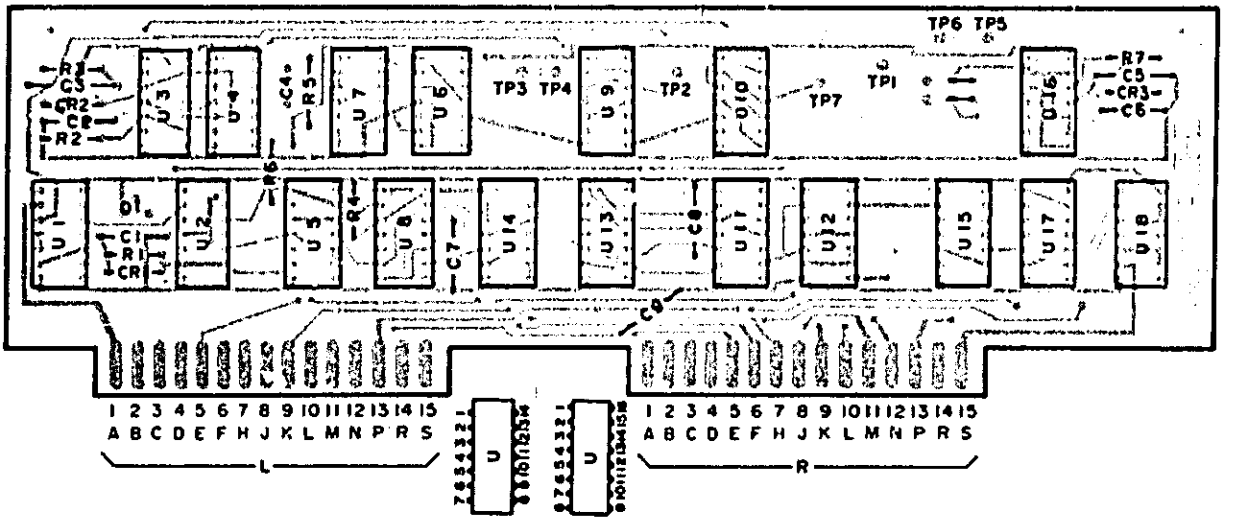


Page 8-57, Figure 8-70, A10 Board Schematic Diagram:
Change the value of A10C1 to 0.47µ.
Change the value of A10C4 to 1µ.
Change the value of A10C31 to 0.1µ

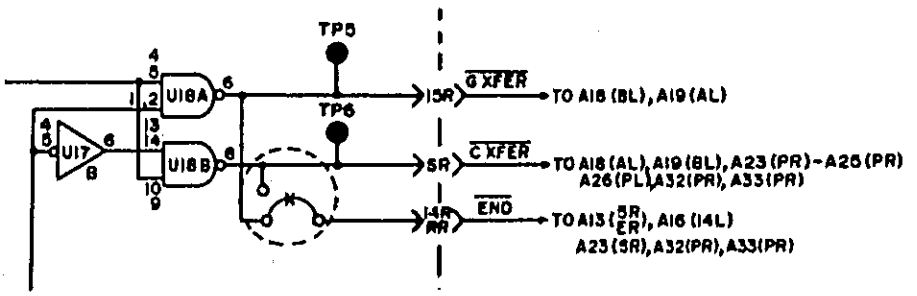
Page 8-59, Figure 8-74, A11 Board Schematic Diagram:
Change the values of A11C17 and C44 to 0.01µ.

Page 8-63, Figure 8-82, A13 Board Schematic Diagram:
Change the value of A13R5 to 8.2K.
Change the value of A13R23 to 270.
Change the value of A13R28 to 75.

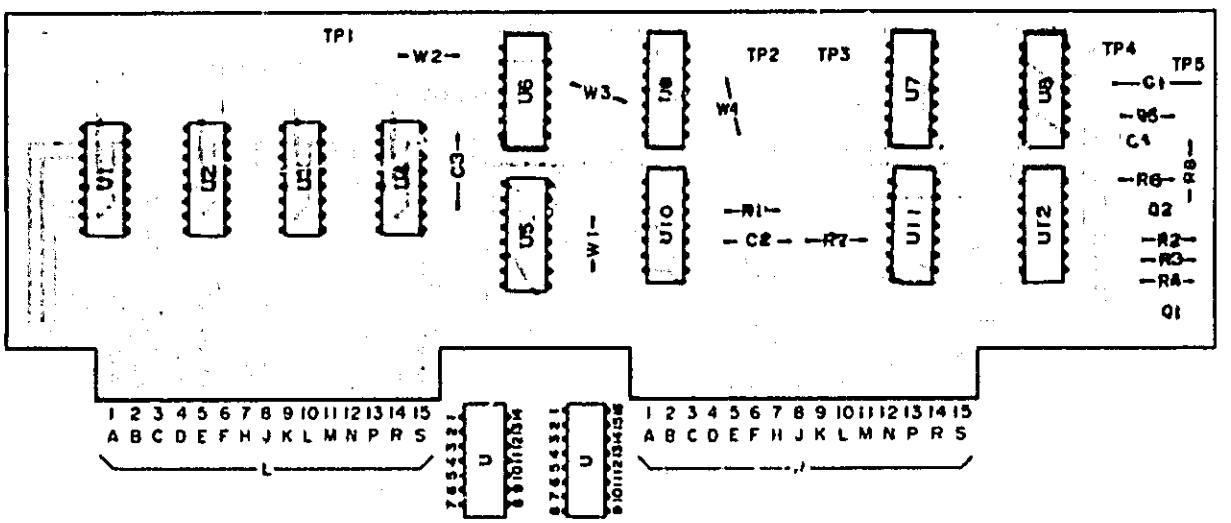
Page 8-65, Figure 8-85, A14 Board Component Locations:
Change the diagram as follows.



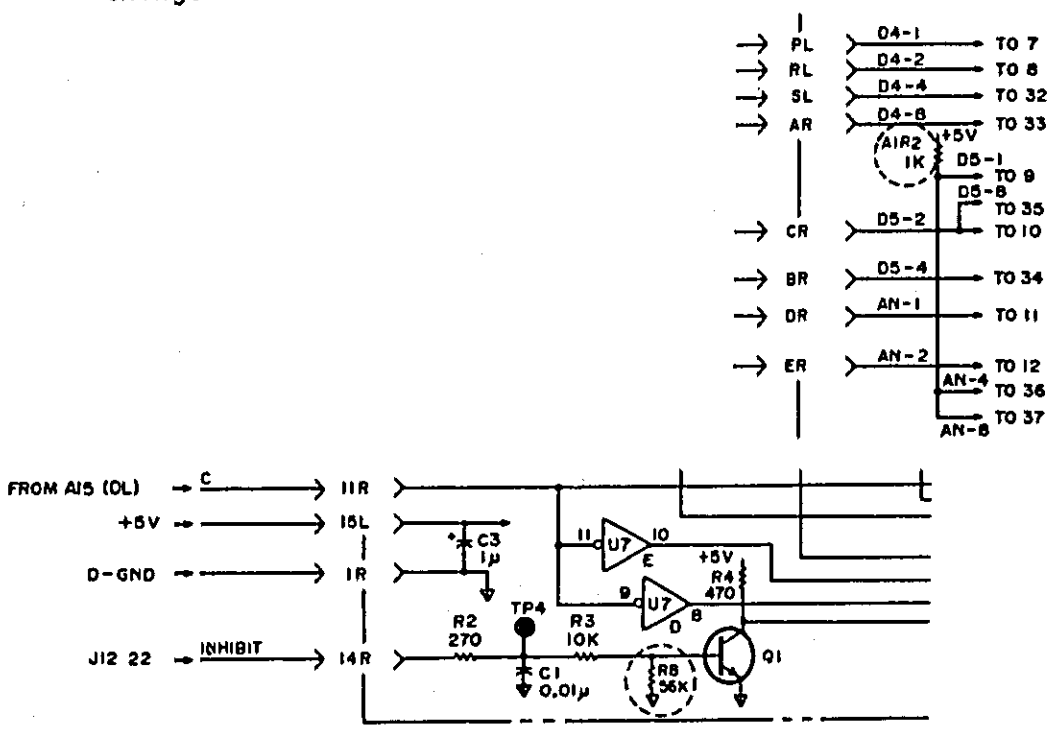
Page 8-65, Figure 8-86, A14 Board Schematic Diagram:
Change the value of A14C6 to 0.047µ.
Change the schematic as shown below.



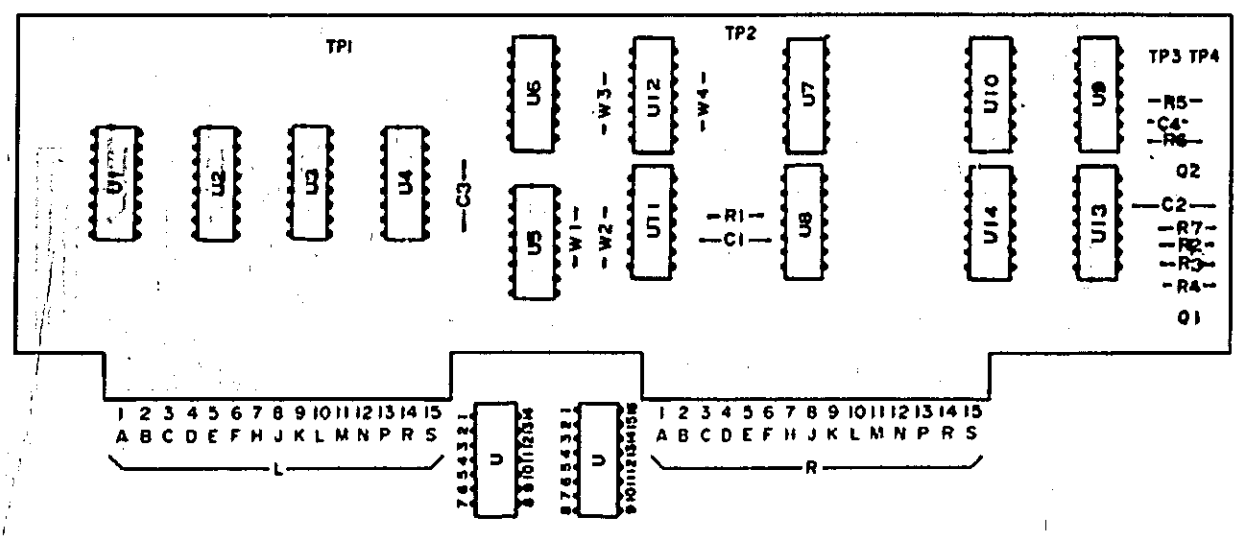
Page 8-79, Figure 8-109, A23 Board Component Locations:
Change the diagram as shown below.



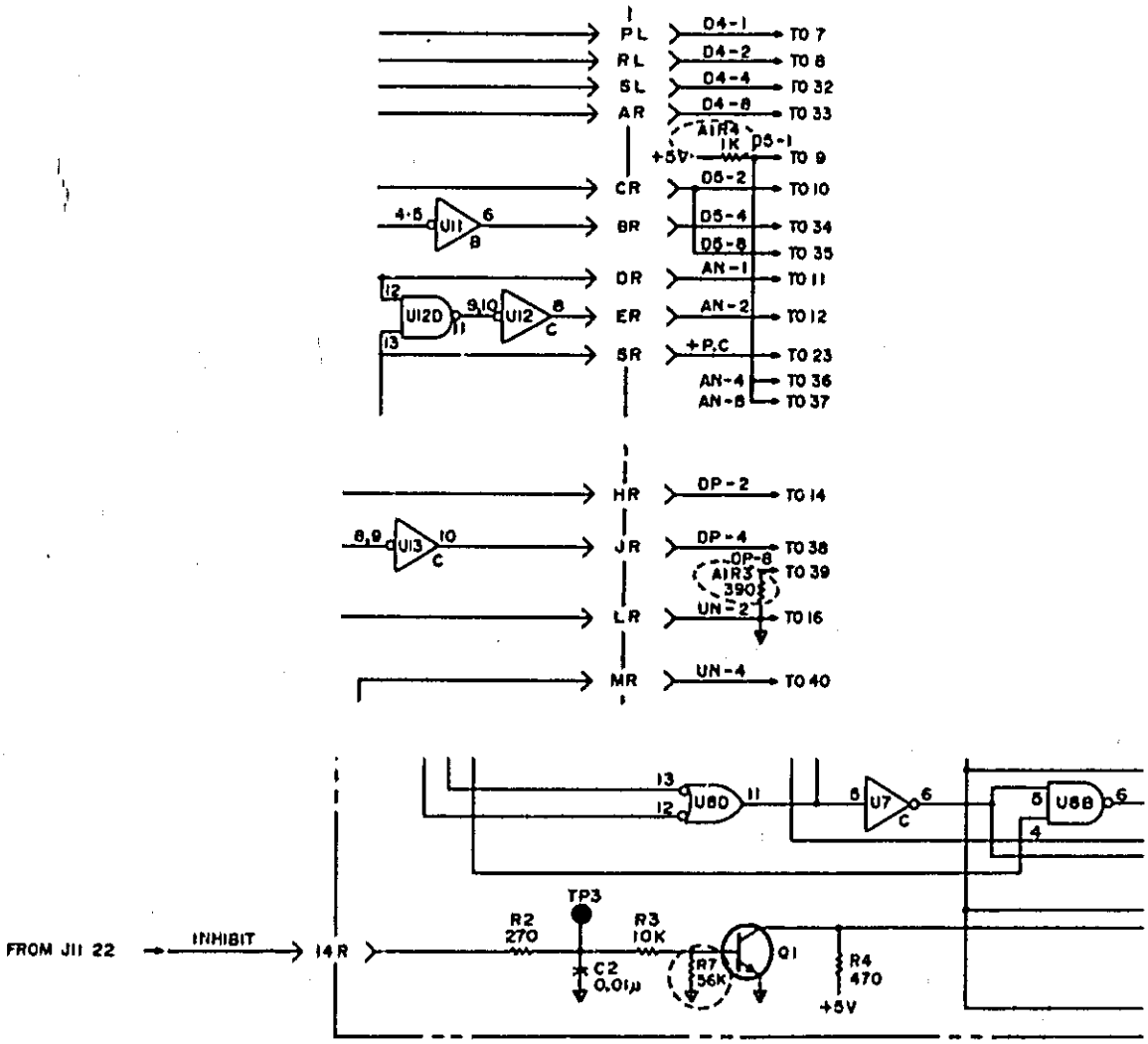
Page 8-79, Figure 8-110, A23 Board Schematic Diagram:
Change the schematic as shown below.



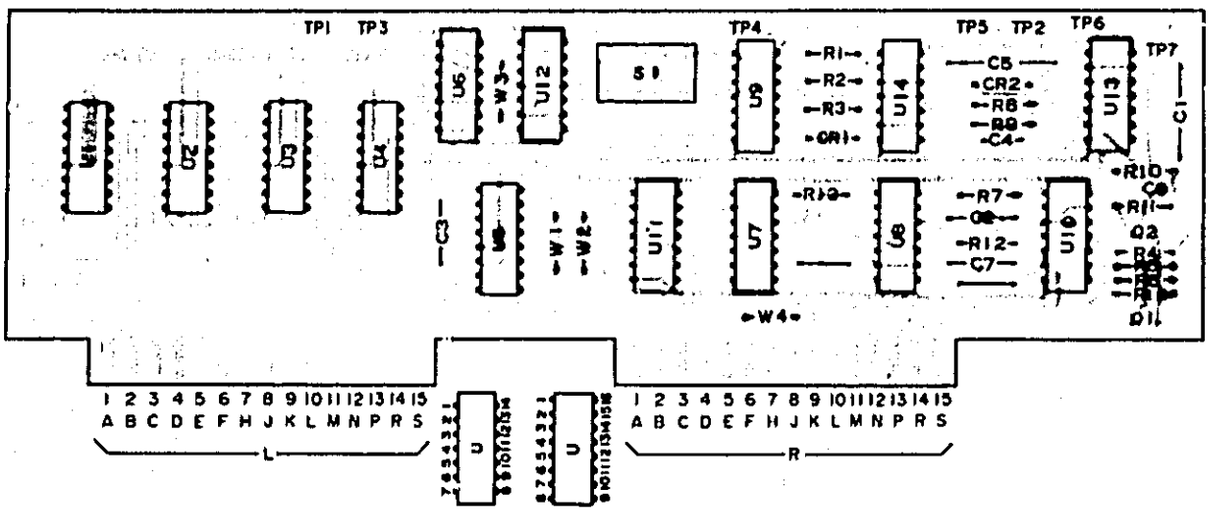
Page 8-81, Figure 8-112, A24 Board Component Locations:
Change the diagram as shown below.



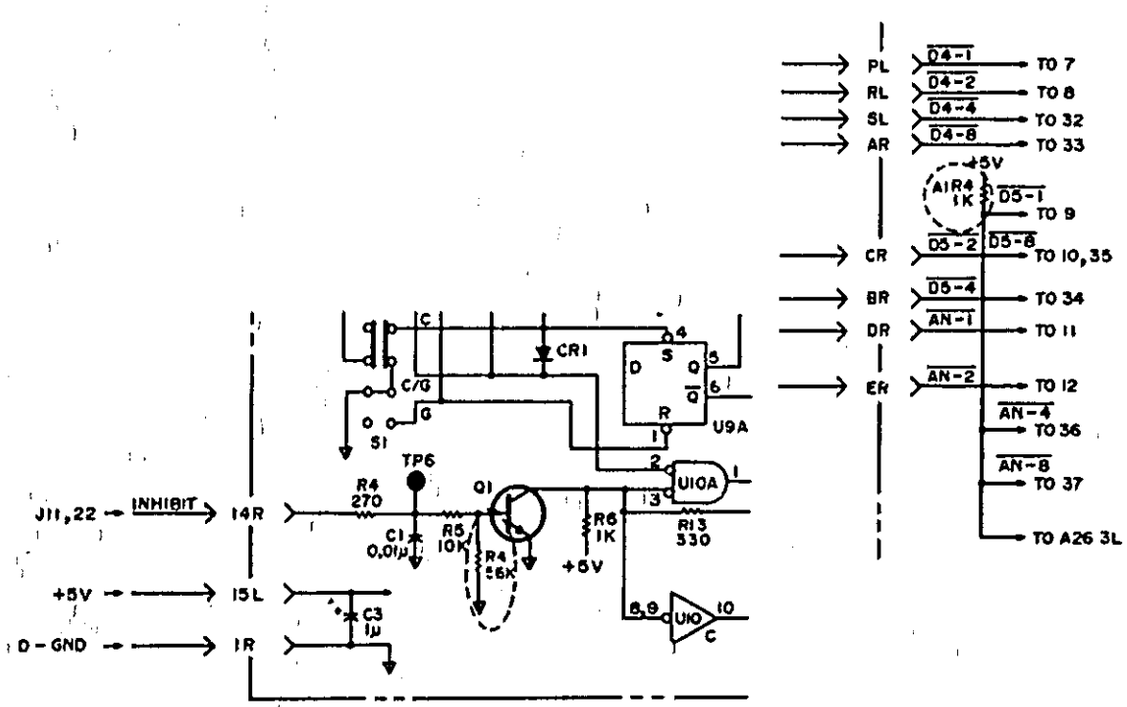
Page 8-81, Figure 8-113, A24 Board Schematic Diagram:
Change the schematic as shown below.



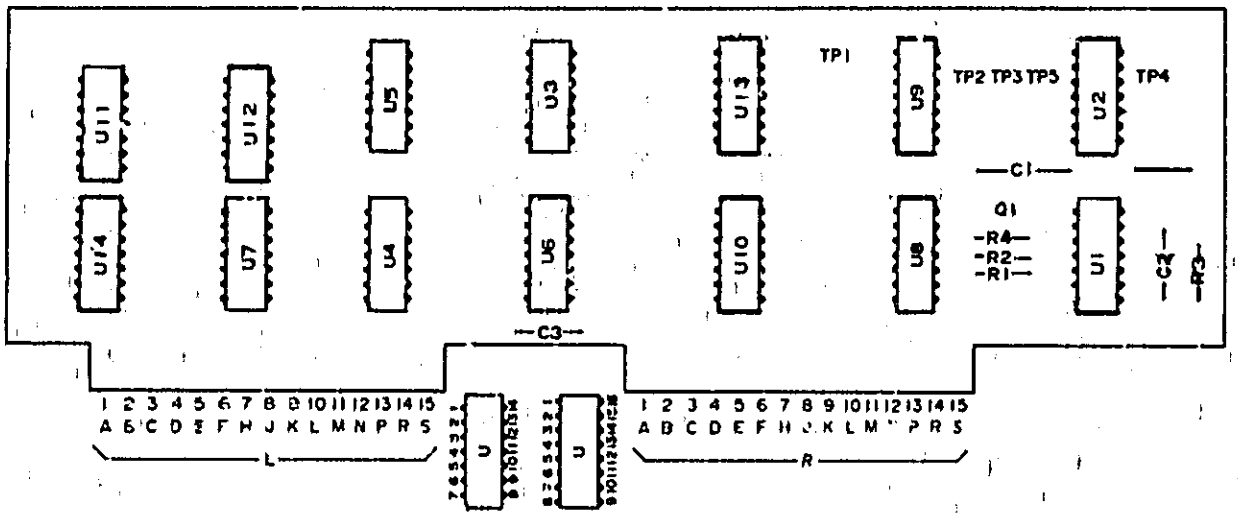
Page 8-83, Figure 8-115, A25 Board Component Locations:
Change the diagram as shown below.



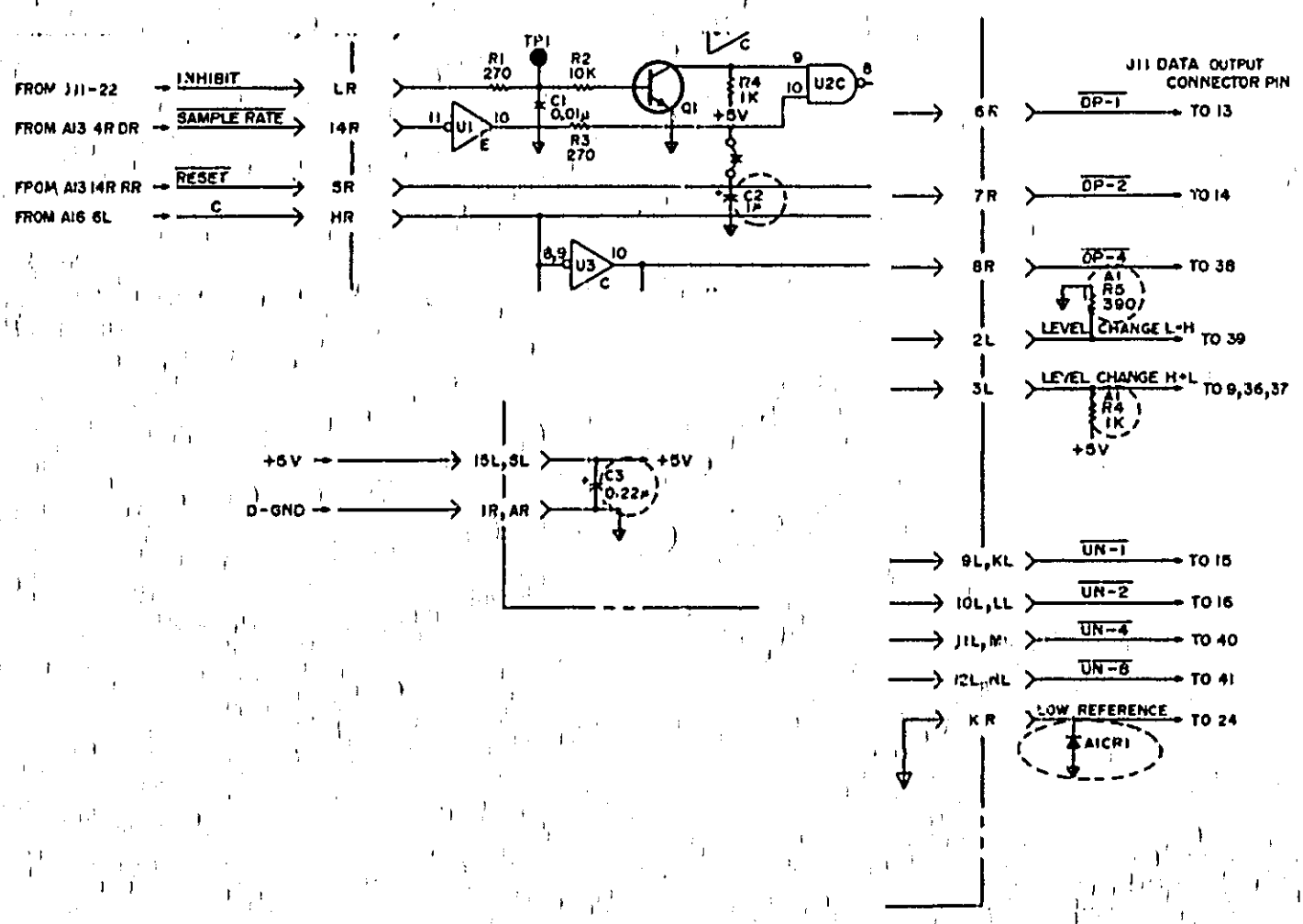
Page 8-83, Figure 8-116, A25 Board Schematic Diagram:
Change the value of A25C5 to 0.022µ.
Change the schematic as shown below.



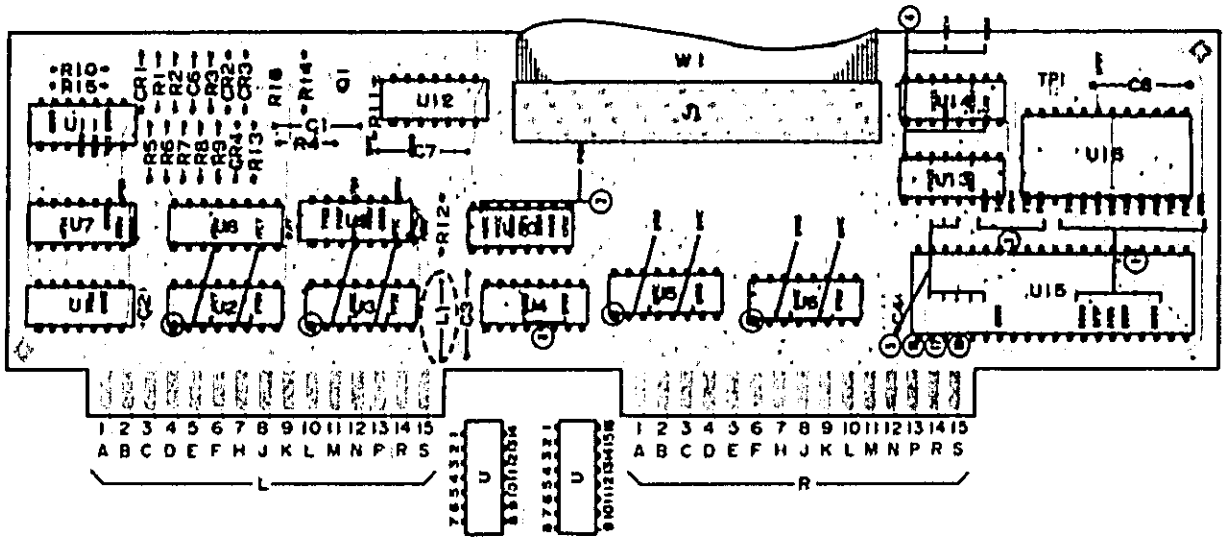
Page 8-85, Figure 8-118, A26 Board Component Locations:
Change the diagram as shown below.



Page 8-85, Figure 8-119, A26 Board Schematic Diagram:
Change the diagram as shown below.



Page 8-87, Figure 8-120, A31 Board Component Locations:
Change the diagram as shown below.



CHANGE 1

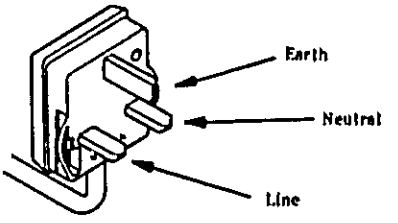
Page 1-9, Table 1-5, Accessories Available:
Delete the column for the 16021A.

Page 2-1, paragraph 2-12:
Change this paragraph as follows:

2-12. To preserve the protection feature when operating the instrument from a two contact outlet, use a three prong to two prong adapter (HP PN 1251-8196) and connect the green grounding tab on the adapter to power line ground.

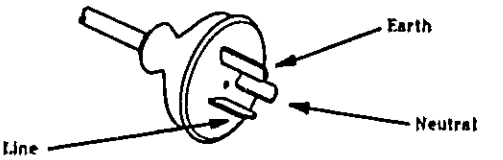
Page 2-3, Figure 2-2, Power Cables:
Change the figure as follows:

OPTION 900 United Kingdom



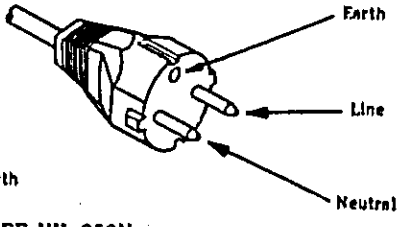
Plug : BS 1363A, 250V
Cable : HP 8120-1351

OPTION 901 Australia/New Zealand



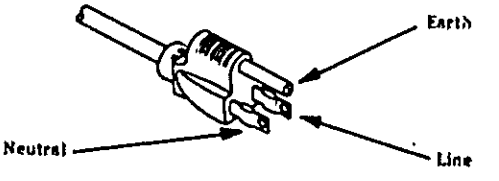
Plug : NZSS 198/AS C112, 250V
Cable : HP 8120-1369

OPTION 902 European Continent



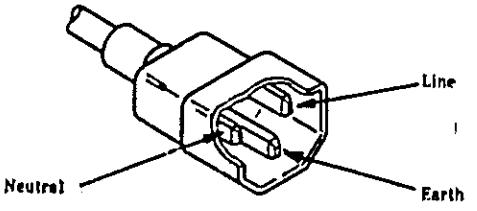
Plug : CEE-VII, 250V
Cable : HP 8120-1689

OPTION 903 U.S./Canada



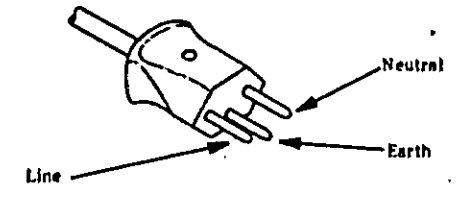
Plug : NEMA 5-15P, 125V, 15A
Cable : HP 8120-1378

OPTION 905* Any country



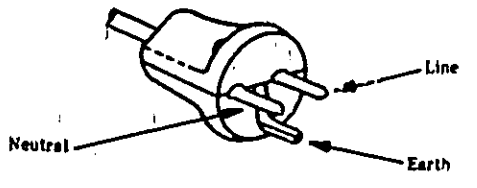
Plug : CEE 22-VI, 250V
Cable : HP 8120-1396

OPTION 906 Switzerland



Plug : SEV 1011.1959-24507 Type 12, 250V
Cable : HP 8120-2104

OPTION 912 Denmark



Plug : DHCR 107, 220V
Cable : HP 8120-2956

* Plug option 905 is frequently used for interconnecting system components and peripherals.

NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90 ° etc.)

Page 4-0, Table 4-1, Recommended Test Equipment:
Change ET-1467, recommended electronic tool, to PN 04271-65003.

Page 5-4, Table 5-2, Factory Selected Components (Sheet 2 of 2)

Component	Nominal Value Range
A12C9	HP PN 0160-2206, C:FXD 160pF
	HP PN 0140-0197, C:FXD 180pF
	HP PN 0140-0198, C:FXD 200pF

Page 5-19, paragraph 5-28, 10000 Counts Adjustment:
Change the part number of the Electronic Tool listed in EQUIPMENT to PN 04271-65003.

Change step a as follows.
a. Set 4271B and Electronic Tool (PN 04271-65003) as shown in Figure 5-17.

Change the title of Figure 5-17 to read.
HP 4271B Connections to Electronic Tool (PN 04271-65003)

Page 6-2, paragraph 6-10, SPARE PARTS KIT :
Delete paragraphs 6-10 and 6-11.

Pages 6-3 to 6-31, Table 6-3, Replaceable Parts:
Refer to the parts change list.

Page 8-43, Figure 8-42, A3 Board Schematic Diagram:
Change the value of A3C6 to 100p.

Page 8-45, Figure 8-46, A4 Board Schematic Diagram:
Change the value of A4CR1 to 6.8V.

Page 8-49, Figure 8-54, A6 board Schematic diagram:
Change the values of A6C4, C19 and C20 to 0.047µ.

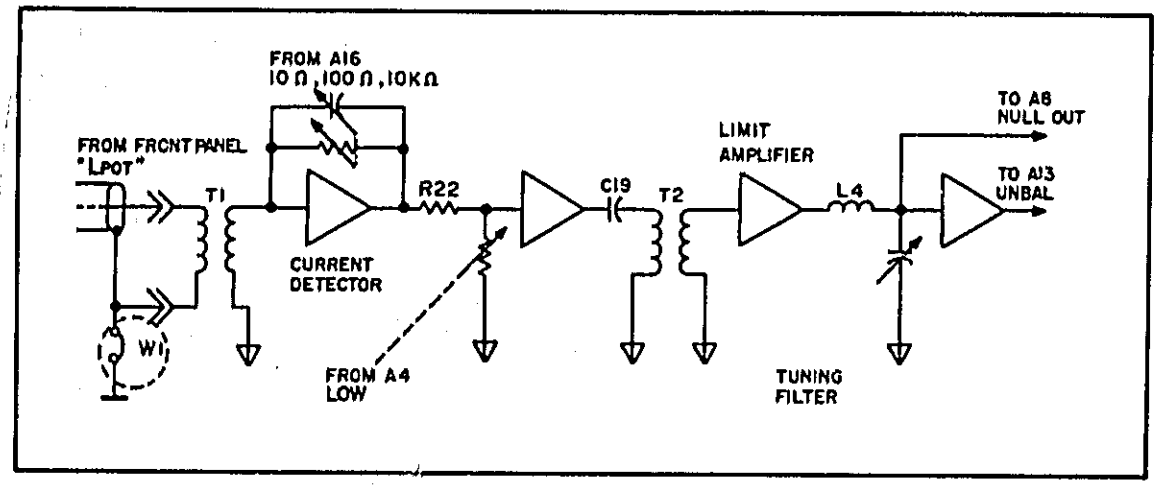
Page 8-51, Figure 8-58, A7 Board Schematic Diagram:
Change the values of A7C4, C19 and C20 to 0.047µ.

Page 8-61, Figure 8-78, A12 Board Schematic Diagram:
Change the value of A12C9* to 200p.
Change the value of A12R42* to 15.4K.
Change the value of A12R56* to 10K.

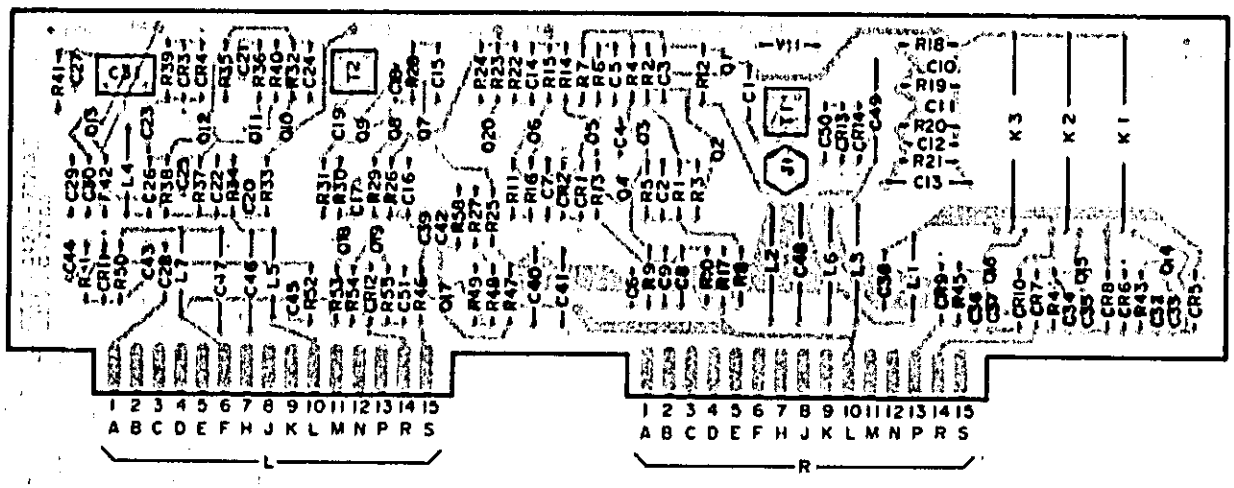
CHANGE 2

Pages 6-17 and 6-23, Table 6-3, Replaceable Parts:
Refer to the parts change list.

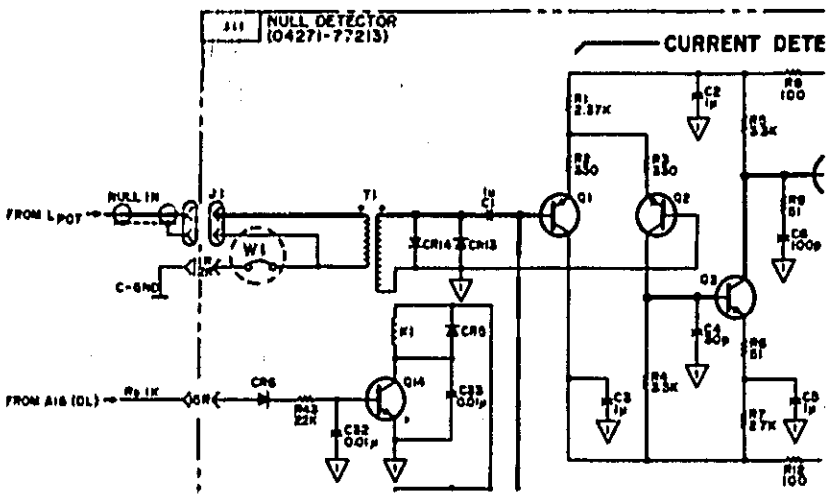
Page 8-58, Figure 8-72, Block Diagram of All Board:
Change the schematic as follows.



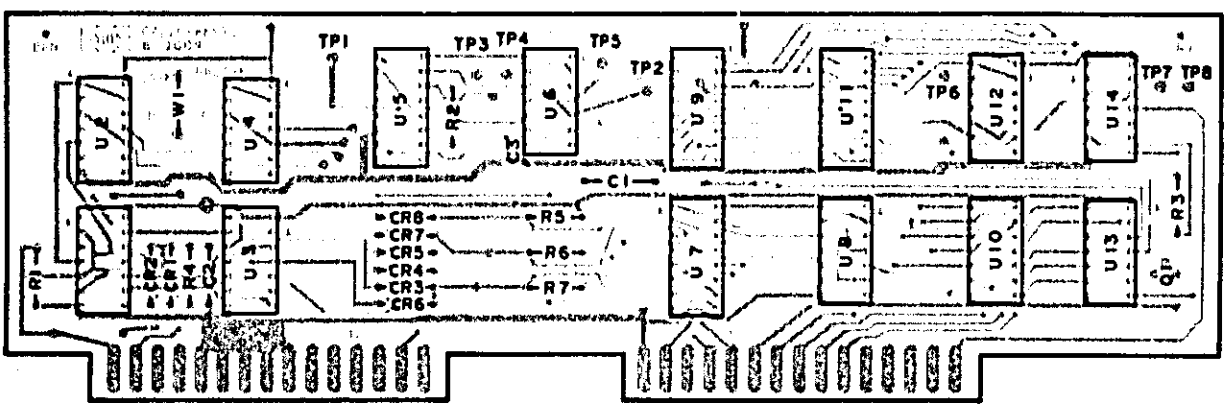
Pages 8-59, Figure 8-73, All Board Component Locations:
Change the diagram as follows.



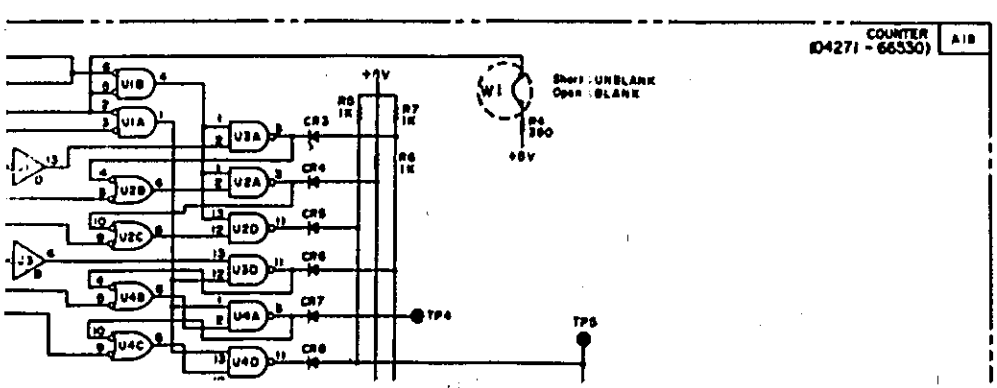
Page 8-59, Figure 8-74, A11 Board Schematic Diagram:
Designate the unmarked jumper W1 as shown below.



Page 8-73, Figure 8-101, A18 Board Component Locations:
Change the diagram as follows.



Page 8-73, Figure 8-102, A18 Board Schematic diagram:
Designate the unmarked jumper W1 as shown below.



CHANGE 3

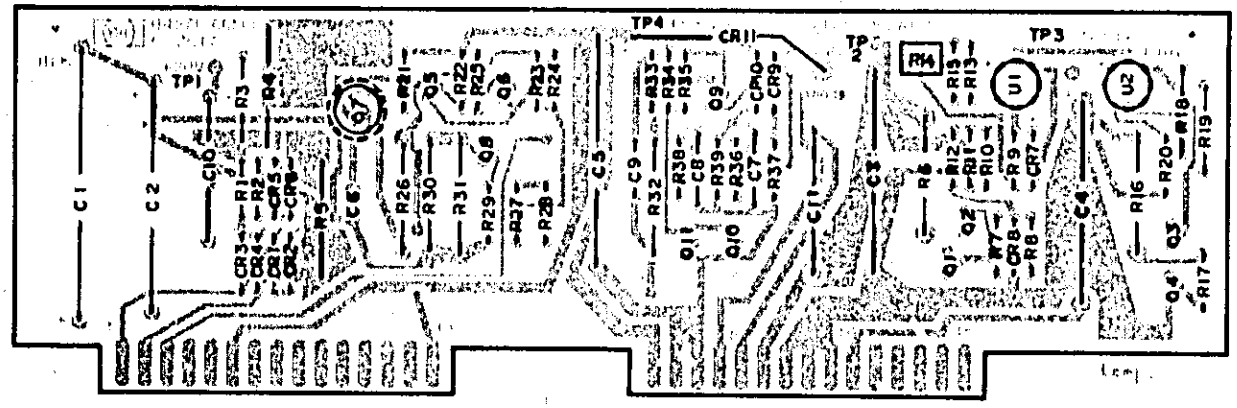
Pages 6-19 amd 6-20, Table 6-3, Replaceable Parts:
Refer to the parts change list.

Page 8-63, Figure 8-82, A13 Board Schematic Diagram:
Change the value of A13C4 to 33µ.
Change the value of A13C5 to 22µ.
Change the value of A13R20 to 30.1K.

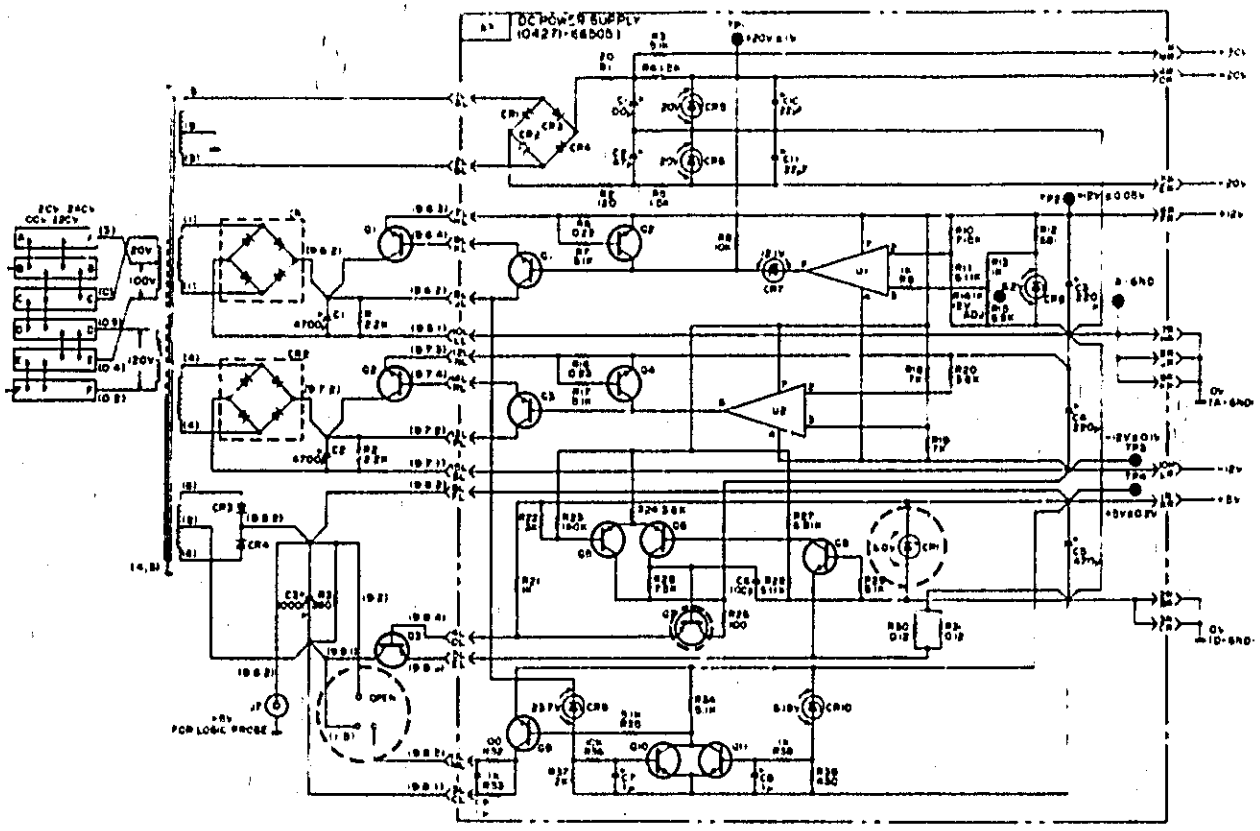
CHANGE 4

Pages 6-4 and 6-30, Table 6-3, Replaceable Parts:
Refer to the parts change list.

Page 8-43, Figure 8-42, A3 Board Component Locations:
Change the diagram as follows.



Page 8-43, Figure 8-42, A3 Board Schematic Diagram:
Change the schematic as follows.



Change the part numbers and descriptions of the replaceable parts in accordance with the table below:

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
ERRATA	6-11	C	A8R39	0683-5625	RESISTOR 5.6K 5% .25W FC TC=-400/+700
		C	A8R52	0683-2025	RESISTOR 2K 5% .25W FC TC=-400/+700
		C	A8R58	0683-2225	RESISTOR 2.2K 5% .25W FC TC=-400/+700
		C	A8R62	0683-5125	RESISTOR 5.1K 5% .25W FC TC=-400/+700
	6-13	C	A10C4	0160-0127	CAPACITOR-FXD 1µF ±20% 25VDC CER
	6-14	C	A10K1	0490-0875	RELAY 2C 12VDC-COIL 2A 30VDC
	6-27	A	A24R7	0683-5635	RESISTOR 56K 5% .25W FC TC=-400/+800
		A	A25R14	0683-5635	RESISTOR 56K 5% .25W FC TC=-400/+800
1	6-4	C	A3C6	0160-2204	CAPACITOR-FXD 100pF+5% 300VDC MICA
		C	A3C10	No change	CAPACITOR-FXD 22µF 63V
		C	A3C11	No change	CAPACITOR-FXD 22µF 63V
		C	A4C1	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4C5	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-5	C	A4C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4C8	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4CR1	1902-1382	DIODE-ZNR 6.8V 5% PD=.4W
		C	A4Q1	5080-3835	No change
		C	A5C5	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C14	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C19	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C20	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C21	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-6	C	A5R35	0698-3154	No change
		C	A6C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C4	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A6C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C9	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C11	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C13	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	▶ A6C15	0160-6406	CAPACITOR-FXD .068µF
		C	A6C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C18	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
1	6-6	C	A6C19	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A6C20	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A6C21	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-7	C	A6C22	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C26	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C27	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A6Q8	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
		▶ C	A6Q13	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
	6-8	C	A7C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C4	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A7C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C9	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C11	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C13	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A7C15	0160-6406	CAPACITOR-FXD .068µF
		C	A7C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C18	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C19	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A7C20	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A7C21	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C22	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C26	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C27	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-9	▶ C	A7Q8	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
		▶ C	A7Q13	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
	6-10	C	A8C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C8	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C27	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C29	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C30	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C40	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C41	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C43	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C44	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8Q1	5080-3830	No change
		C	A8Q2	5080-3830	No change
		C	A8Q3	5080-3830	No change

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
1	6-10	C	A8Q4	5080-3830	No change
		C	A8Q9	5080-3830	No change
		C	A8Q11	5080-3830	No change
	6-12	C	A9C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A9C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-13	C	A10C3	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A10C10	0160-4796	CAPACITOR-FXD 3.9pF ±0.25pF
		C	A10C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C13	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C15	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C23	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C24	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C31	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-14	C	A10Q5	5080-3830	No change
		C	A10Q10	5080-3830	No change
		C	A10Q12	5080-3835	No change
		C	A10Q14	5080-3835	No change
	6-15	C	A11C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C15	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C22	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C24	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-16	C	A11C26	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C29	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C30	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C51	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-17	C	A12C9*	0140-0198	CAPACITOR-FXD 200pF ±5% 300VDC MICA
	6-19	C	A12R42*	0698-3540	RESISTOR 15.4K 1% .125W F TC=0±100
		C	A12R56*	0757-0442	RESISTOR 10K 1% .125W F TC=0±100
		C	A13C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A13C11	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A13C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-20	C	A14C6	0160-4834	CAPACITOR-FXD .047µF ±10% 50VDC CER
		▶ C	A14C9	0160-4574	CAPACITOR-FXD 1000pF
	6-23	C	A18C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A18C3	0160-4574	CAPACITOR-FXD 1000pF

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
	6-26	C C C	A21U4 A21U5 A21U6	1820-1411 1820-1411 1820-1411	IC LCH TTL LS D-TYPE 4-BIT IC LCH TTL LS D-TYPE 4-BIT IC LCH TTL LS D-TYPE 4-BIT
	6-28	C	A31C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-29	C C	A34J1 A34J2	1200-0607 1200-0607	No change No change
1	6-30	C	J5	1510-0310	No change
2	6-17	A	A11W1	8159-0005	RESISTOR-ZERO OHMS 22 AWG LEAD DIA
	6-23	A	A18W1	8159-0005	RESISTOR-ZERO OHMS 22 AWG LEAD DIA
3	6-19	C C	A13C4 A13C5	0180-0229 0180-0228	CAPACITOR-FXD 33µF CAPACITOR-FXD 22uF
	6-20	C C	A13R20 A13U5	0757-0453 1820-0371	RESISTOR 30.1K 1% .125W F TC=0±100 IC GATE TTL H NAND TPL 3-INP
4	6-4	A	A3CR11	1902-0552	DIODE-ZNR 6.0V
	6-30	D	CR5	1884-0005	DIODE: THYRISTOR (SCR) 50V

▶: New item C: Change D: Delete A: Add

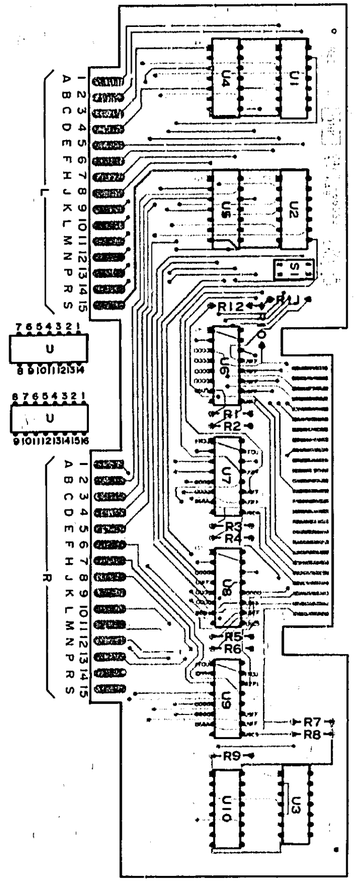


Figure 8-124. A33 HP-IB Data Board Assembly Component Locations.

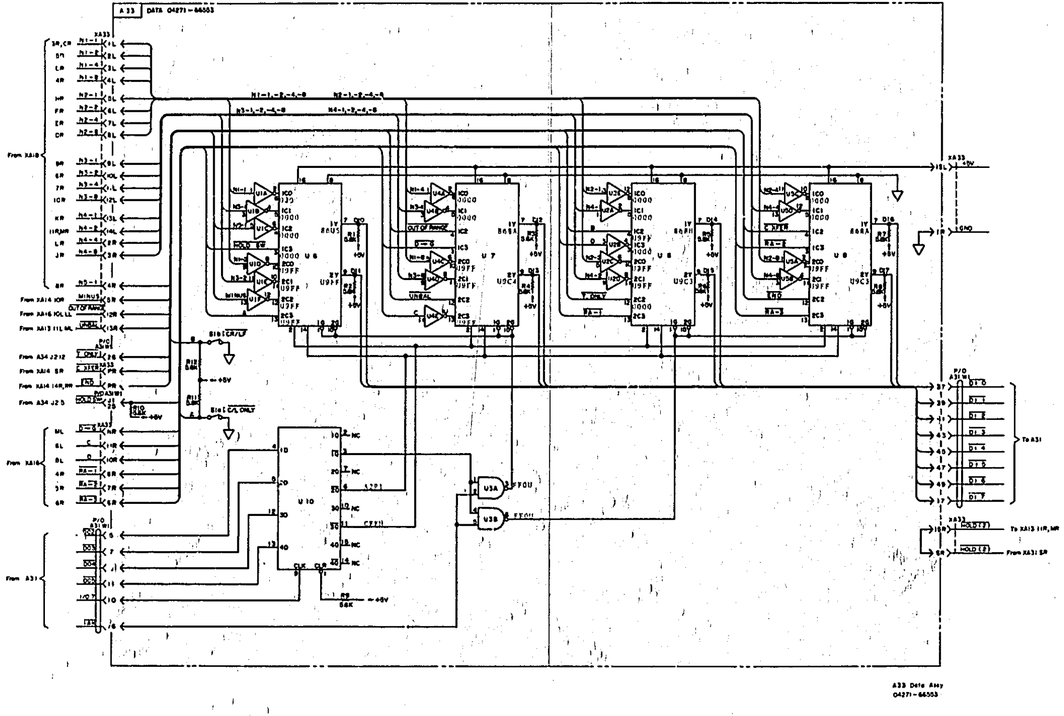


Figure 8-125. A33 HP-IB Data Board Assembly Schematic Diagram.

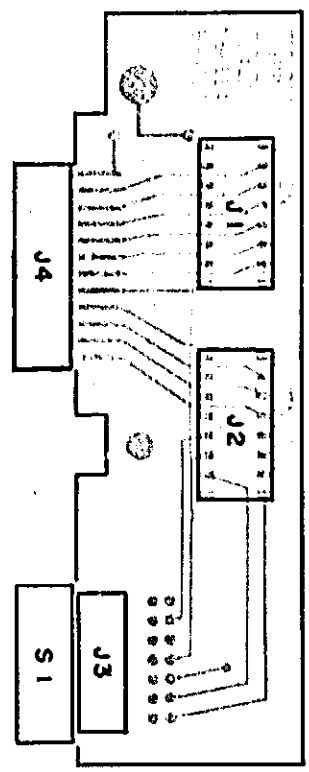


Figure 8-126. HP-IB Connector Board Assembly Component Locations.

MANUAL CHANGES

4271B

1MHz DIGITAL LCR METER

MANUAL IDENTIFICATION

Model Number: 4271B
Date Printed: APR. 1982
Part Number: 04271-90003

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:
Make all ERRATA corrections.
Make all appropriate serial number related changes indicated in the tables below.

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
ALL	1
1838J00801 and above	2
1838J01410 and above	3
1838J01416 and above	4

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES

► NEW ITEM

ERRATA

►Page 3-20, Figure 3-10:
Change the signal names of pins 7 and 14 to N.C. (not connected).

Page 4-0, Table 4-1, Recommended Test Equipment:
Delete 15pF (PN 0160-2261) and 7500pF (PN 0160-2355) capacitors.

Add the following 1pF capacitor.

1pF ±0.25pF PN 0160-2236

Delete 1MΩ resistor (PN 0698-1055).

Page 5-16, paragraph 5-25, Dynamic Range Adjustment:
Change the part number for the 1pF capacitor in step c to read:

HP PN 0160-2236.

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

HEWLETT PACKARD

Printed in Japan

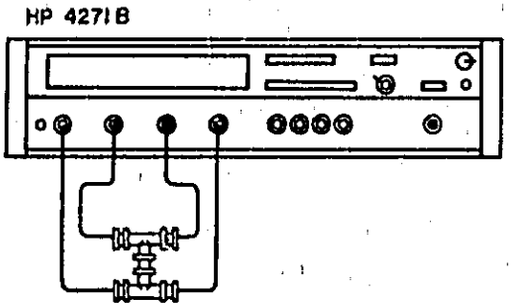
Page 5-22, paragraph 5-31, C-G OFFSET Counts Adjustment:
Change step d as follows.

... Then set C OFFSET ADJ fully ccw and read display ...

Page 5-23, paragraph 5-32, L-R OFFSET Counts Adjustment:

Change the part number of the BNC adapter (HP PN 1250-0081) to 1250-0080.

Change Figure 5-18 as shown below.



Pages 6-11, 6-13, 6-14, and 6-27, Table 6-3, Replaceable Parts:

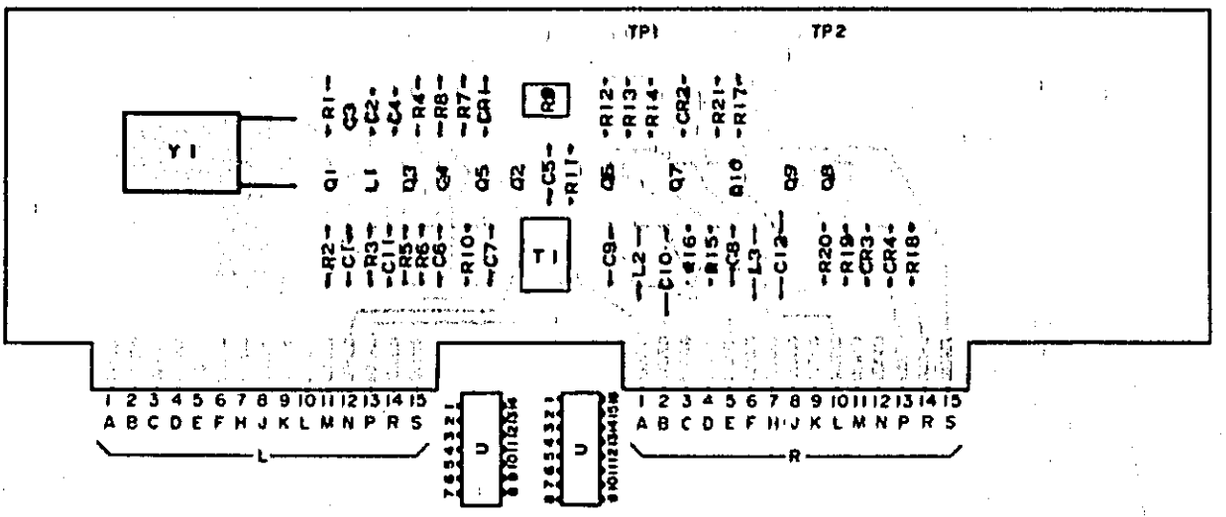
Refer to the parts change list.

Page 8-43, Figure 8-42, A3 Board Schematic Diagram:

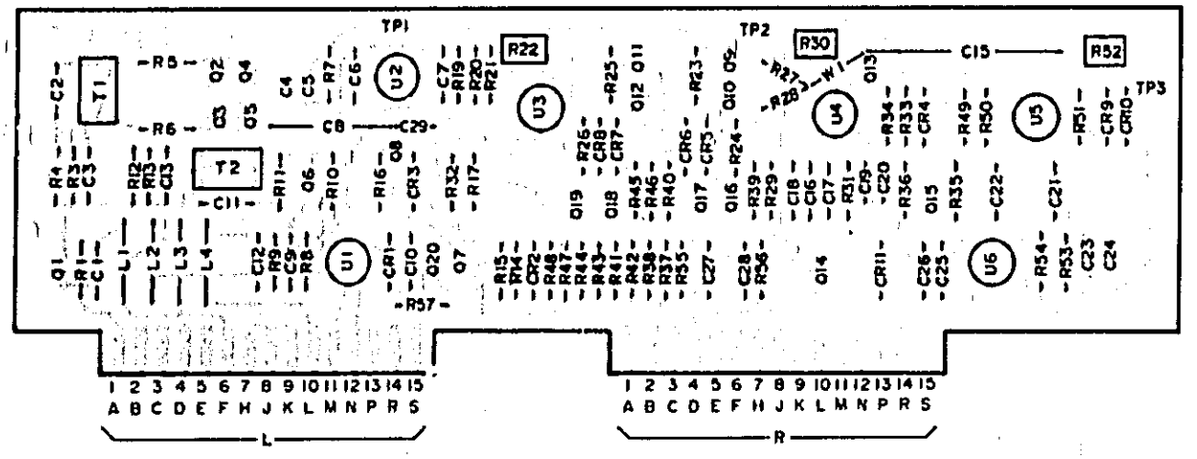
Change the value of A3R23 to 160K.

Page 8-45, Figure 8-45, A4 Board Component Locations:

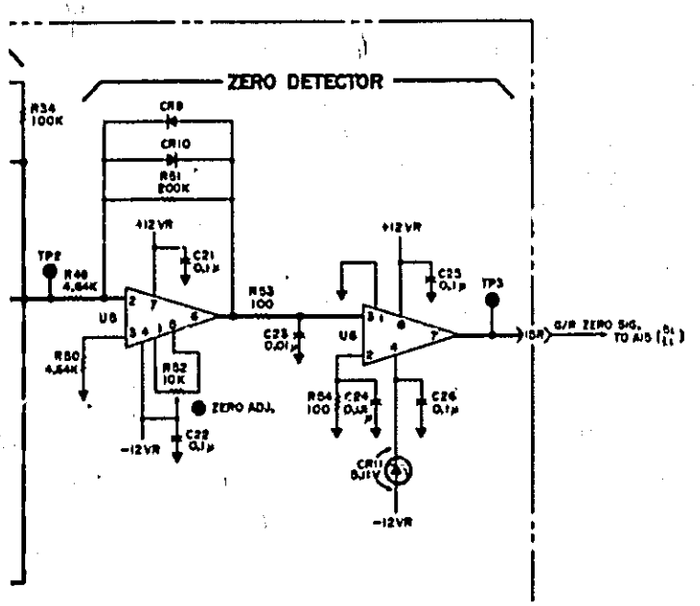
Change the diagram as follows.



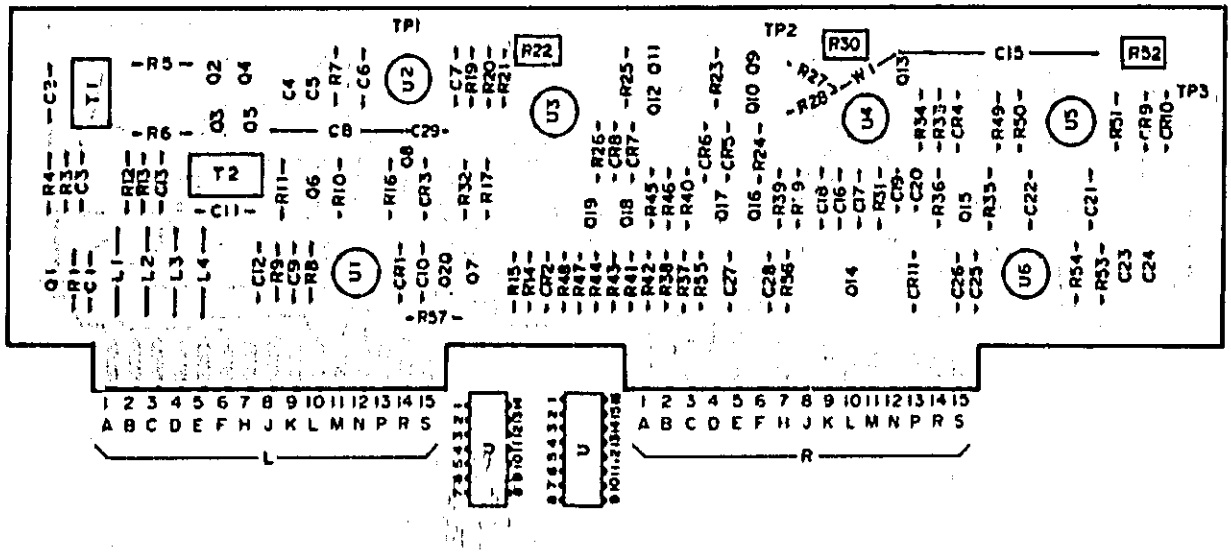
Page 8-49, Figure 8-53, A6 Board Component Locations:
Change the diagram as follows.



Page 8-49, Figure 8-54, A6 Board Schematic Diagram:
Change the schematic as shown below.

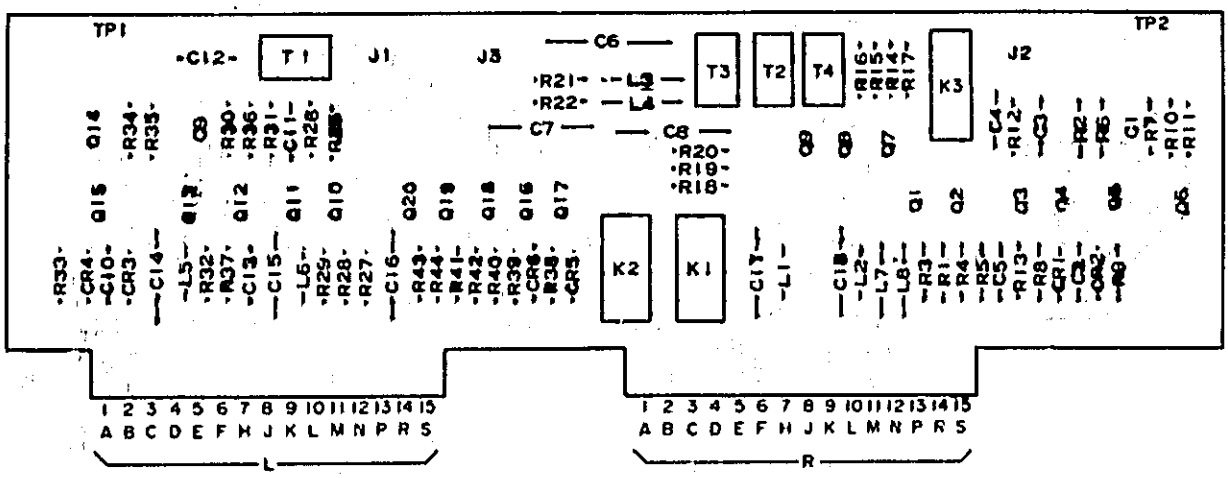


Page 8-51, Figure 8-57, A7 Board Component Locations:
Change the diagram as follows.

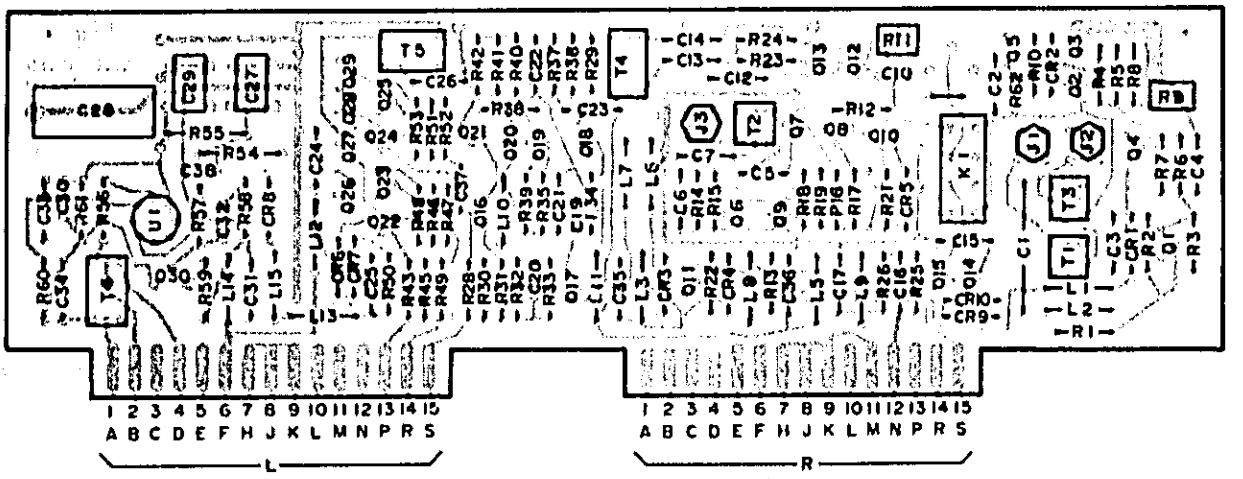


Page 8-53, Figure 8-62, A8 Board Schematic Diagram:
Change the value of A8C3 to 0.01μ.
Change the value of A8CR1 to 7.5V.
Change the value of A8R39 to 5.6K.
Change the value of A8R52 to 2K.
Change the value of A8R58 to 2.2K.
Change the value of A8R62 to 5.1K.

Page 8-55, Figure 8-65, A9 Board Component Locations:
Change the diagram as follows.



Page 8-57, Figure 8-69, A10 Board Component Locations:
Change the diagram as follows.

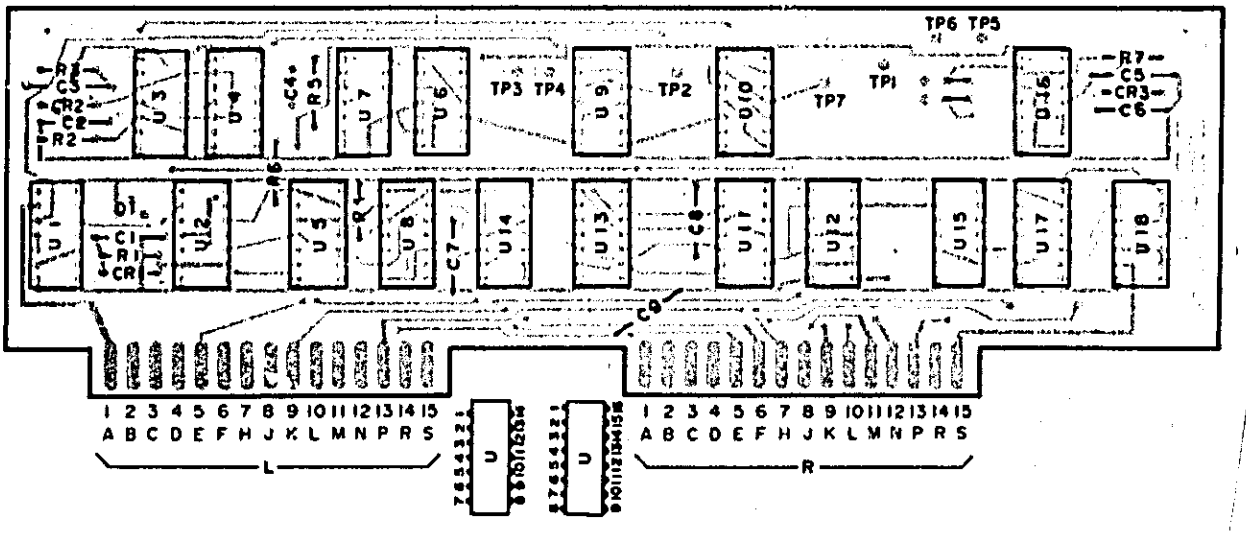


Page 8-57, Figure 8-70, A10 Board Schematic Diagram:
Change the value of A10C1 to 0.47µ.
Change the value of A10C4 to 1µ.
Change the value of A10C31 to 0.1µ

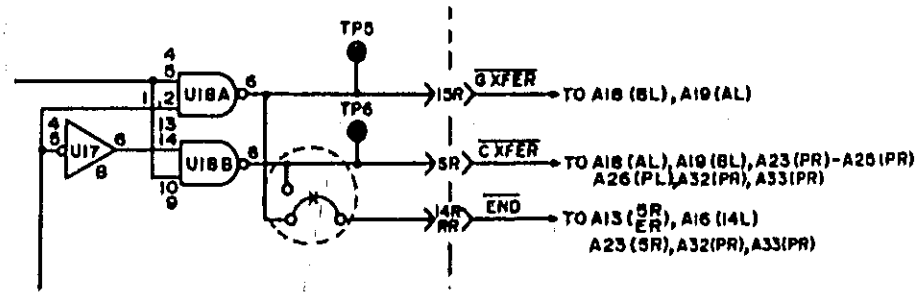
Page 8-59, Figure 8-74, A11 Board Schematic Diagram:
Change the values of A11C17 and C44 to 0.01µ.

Page 8-63, Figure 8-82, A13 Board Schematic Diagram:
Change the value of A13R5 to 8.2K.
Change the value of A13R23 to 270.
Change the value of A13R28 to 75.

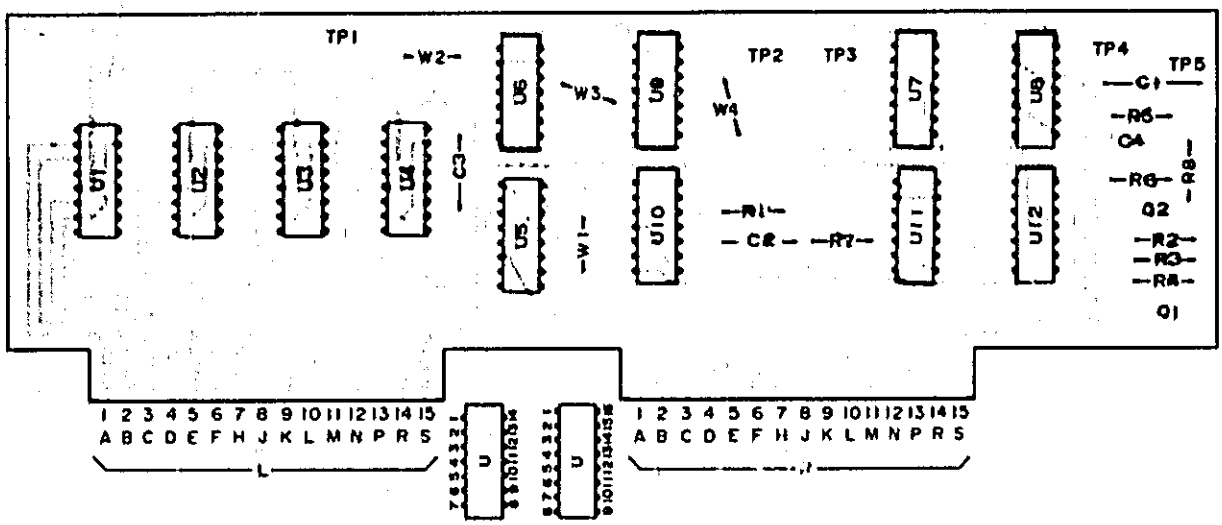
Page 8-65, Figure 8-85, A14 Board Component Locations:
Change the diagram as follows.



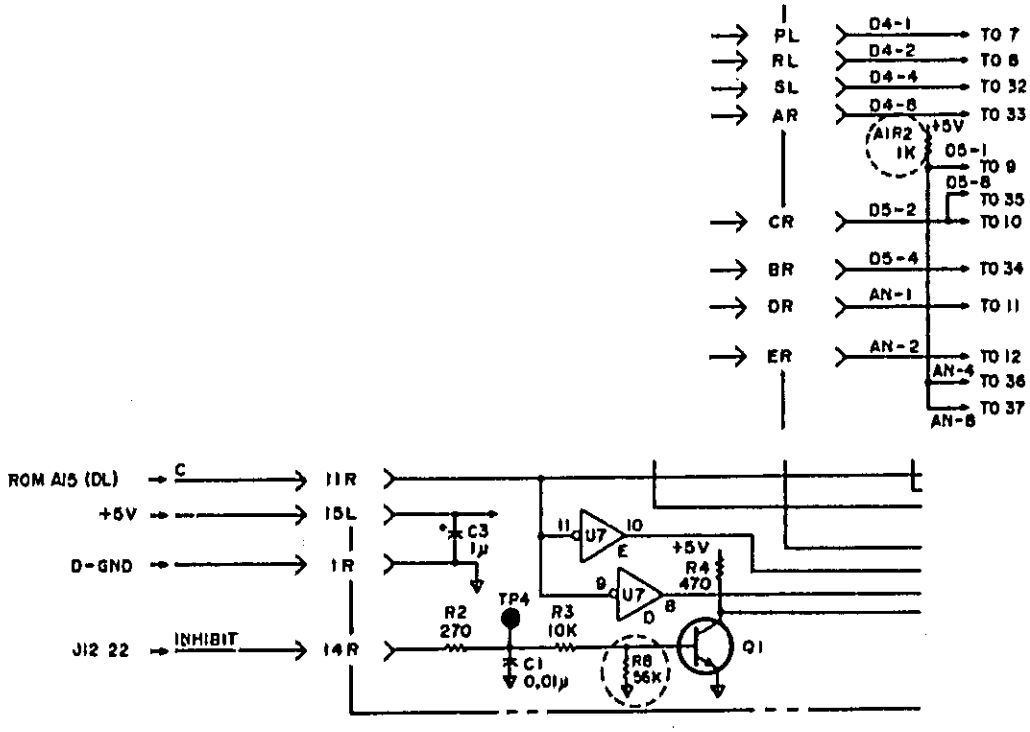
Page 8-65, Figure 8-86, A14 Board Schematic Diagram:
Change the value of A14C6 to 0.047µ.
Change the schematic as shown below.



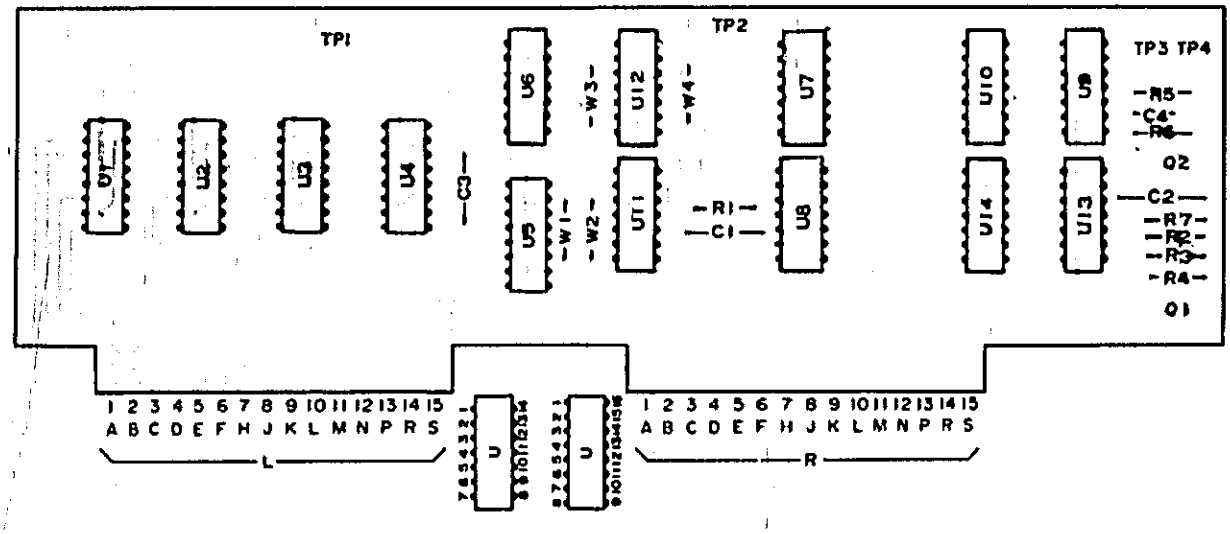
Page 8-79, Figure 8-109, A23 Board Component Locations:
Change the diagram as shown below.



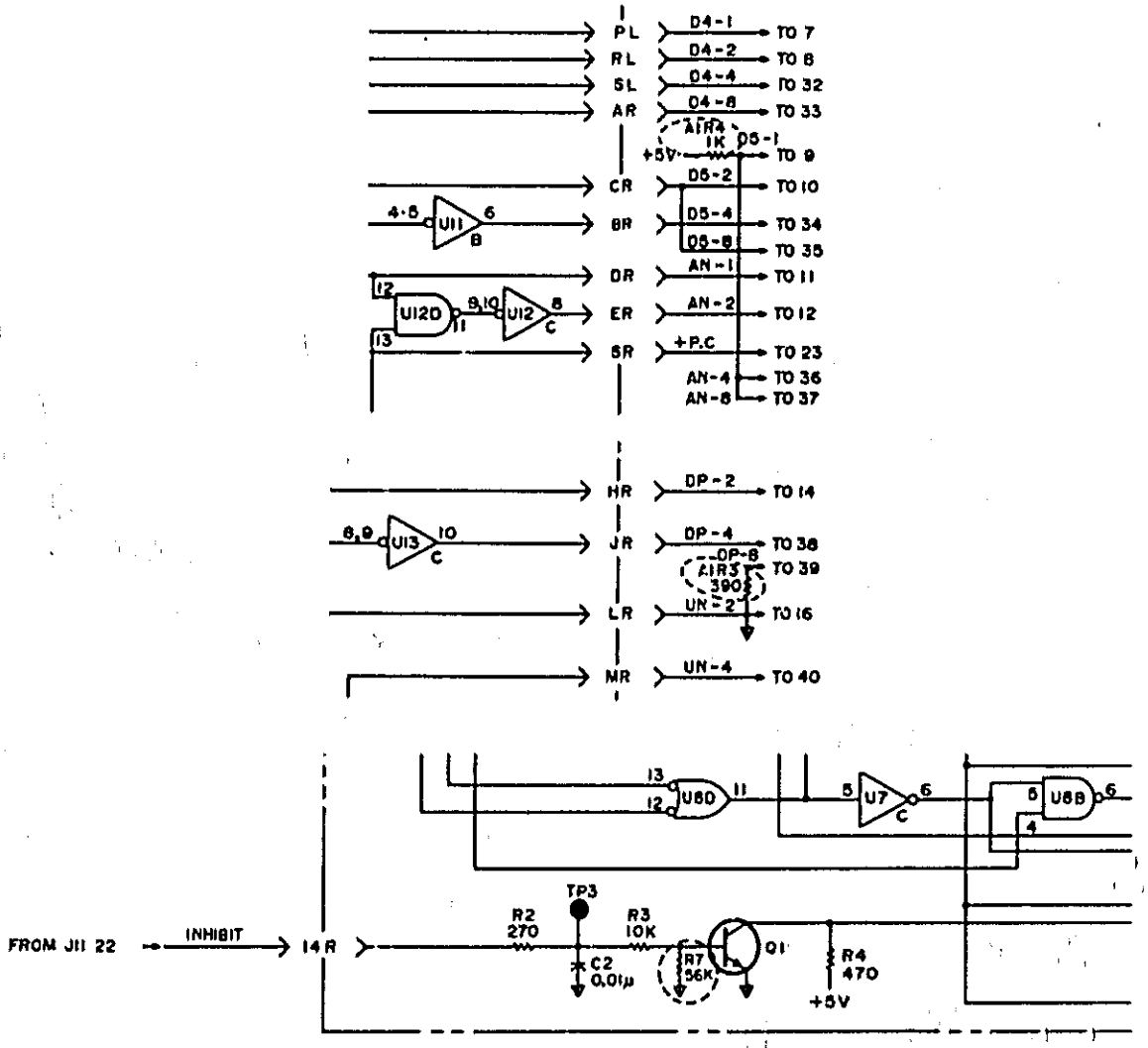
Page 8-79, Figure 8-110, A23 Board Schematic Diagram:
Change the schematic as shown below.



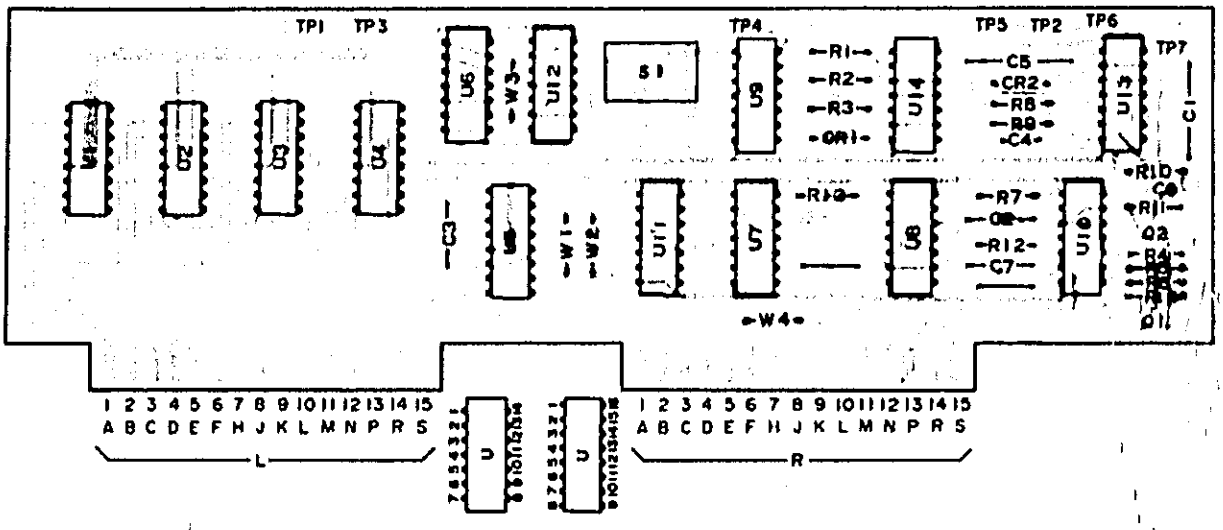
Page 8-81, Figure 8-112, A24 Board Component Locations:
Change the diagram as shown below.



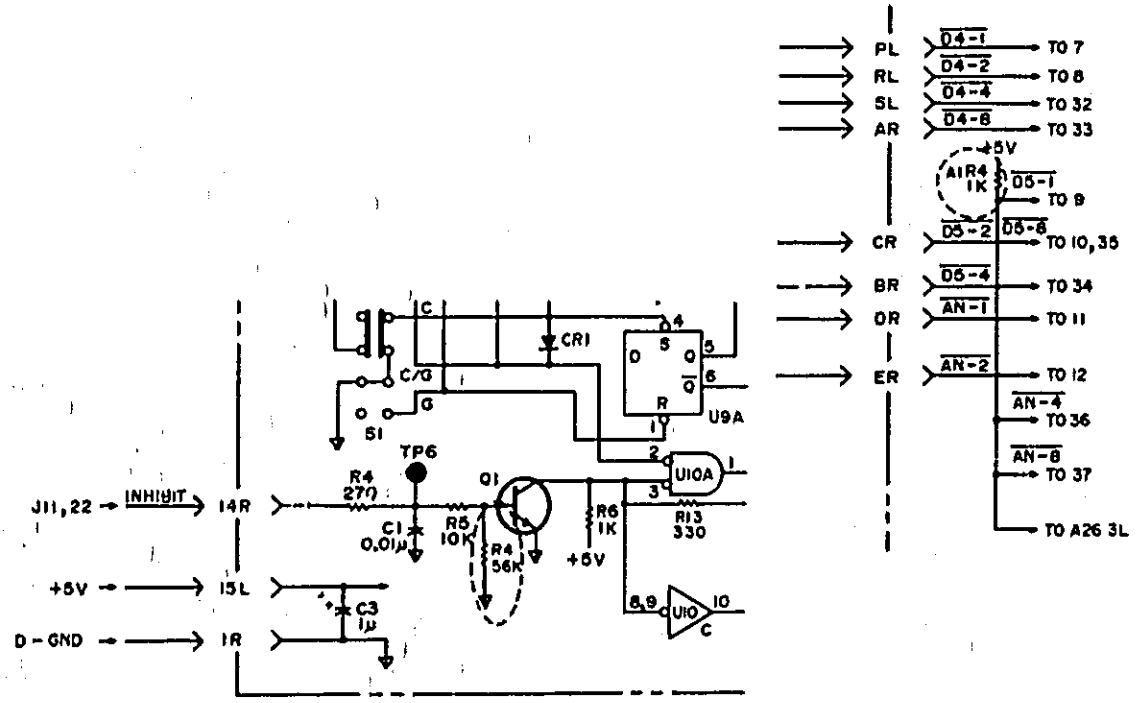
Page 8-81, Figure 8-113, A24 Board Schematic Diagram:
Change the schematic as shown below.



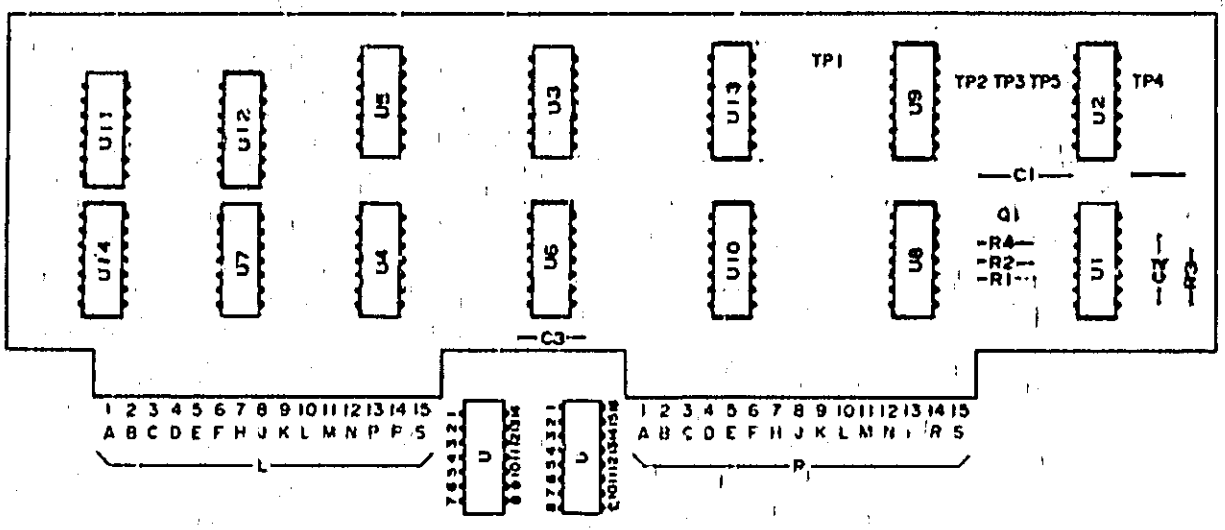
Page 8-83, Figure 8-115, A25 Board Component Locations:
Change the diagram as shown below.



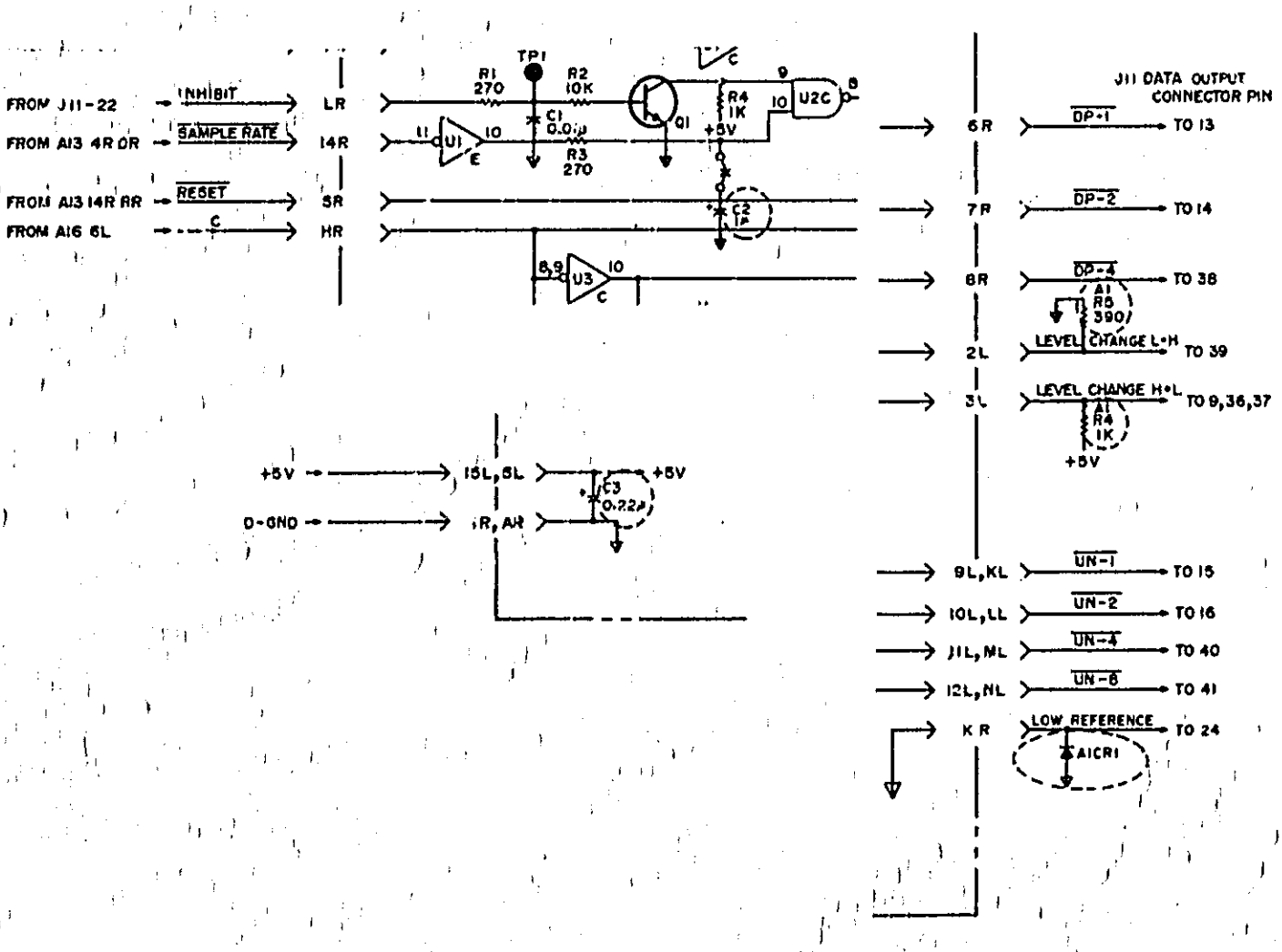
Page 8-83, Figure 8-116, A25 Board Schematic Diagram:
Change the value of A25C5 to 0.022µ.
Change the schematic as shown below.



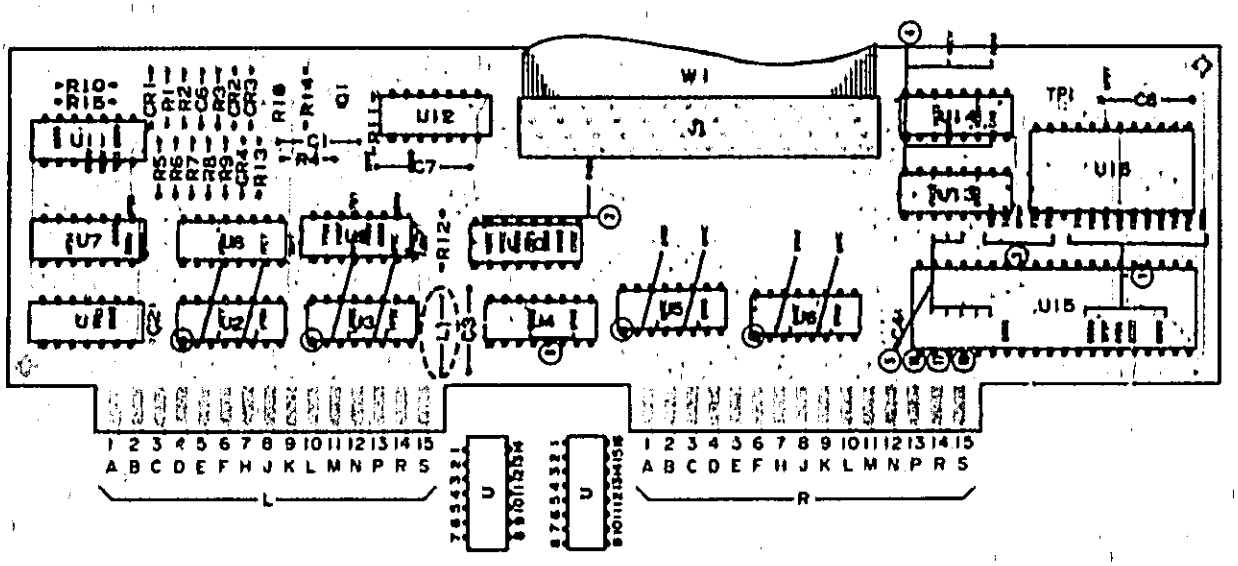
Page 8-85, Figure 8-118, A26 Board Component Locations:
Change the diagram as shown below.



Page 8-85, Figure 8-119, A26 Board Schematic Diagram:
Change the diagram as shown below.



Page 8-87, Figure 8-120, A31 Board Component Locations:
Change the diagram as shown below.



CHANGE 1

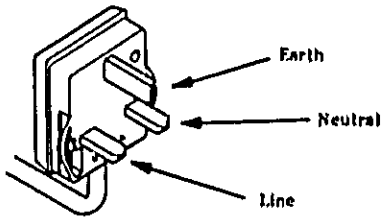
Page 1-9, Table 1-5, Accessories Available:
Delete the column for the 16021A.

Page 2-1, paragraph 2-12:
Change this paragraph as follows:

2-12. To preserve the protection feature when operating the instrument from a two contact outlet, use a three prong to two prong adapter (HP PN 1251-8196) and connect the green grounding tab on the adapter to power line ground.

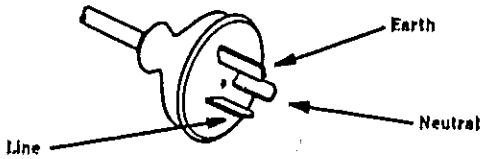
Page 2-3, Figure 2-2, Power Cables:
Change the figure as follows:

OPTION 900 United Kingdom



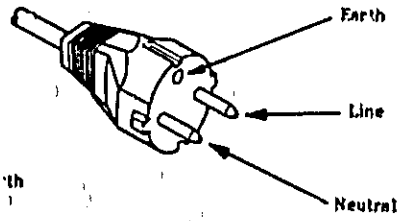
Plug : BS 1363A, 250V
Cable : HP 8120-1351

OPTION 901 Australia/New Zealand



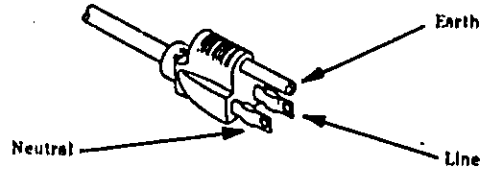
Plug : NZSS 198/AS C112, 250V
Cable : HP 8120-1369

OPTION 902 European Continent



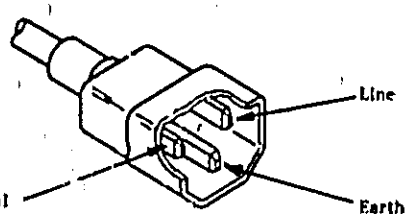
Plug : CEE-VII, 250V
Cable : HP 8120-1689

OPTION 903 U.S./Canada



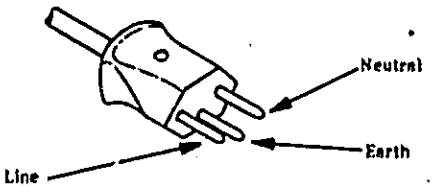
Plug : NEMA 5-15P, 125V, 15A
Cable : HP 8120-1378

OPTION 905* Any country



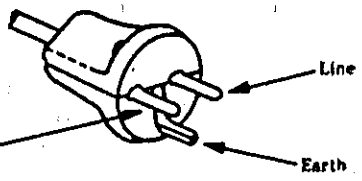
Plug : CEE 22-VI, 250V
Cable : HP 8120-1396

OPTION 906 Switzerland



Plug : SEV 1011.1959-24507 Type 12, 250V
Cable : HP 8120-2104

OPTION 912 Denmark



Plug : DHCR 107, 220V
Cable : HP 8120-2956

* Plug option 905 is frequently used for interconnecting system components and peripherals.

NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90 ° etc.)

Page 4-0, Table 4-1, Recommended Test Equipment:
Change ET-1467, recommended electronic tool, to PN 04271-65003.

Page 5-4, Table 5-2, Factory Selected Components (Sheet 2 of 2):

Component	Nominal Value Range
A12C9	HP PN 0160-2206, C:FXD 160pF
	HP PN 0140-0197, C:FXD 180pF
	HP PN 0140-0198, C:FXD 200pF

Page 5-19, paragraph 5-28, 10000 Counts Adjustment:
Change the part number of the Electronic Tool listed in EQUIPMENT to PN 04271-65003.

Change step a as follows.

a. Set 4271B and Electronic Tool (PN 04271-65003) as shown in Figure 5-17.

Change the title of Figure 5-17 to read.
HP 4271B Connections to Electronic Tool (PN 04271-65003)

Page 6-2, paragraph 6-10, SPARE PARTS KIT :
Delete paragraphs 6-10 and 6-11.

Pages 6-3 to 6-31, Table 6-3, Replaceable Parts:
Refer to the parts change list.

Page 8-43, Figure 8-42, A3 Board Schematic Diagram:
Change the value of A3C6 to 100p.

Page 8-45, Figure 8-46, A4 Board Schematic Diagram:
Change the value of A4CR1 to 6.8V.

Page 8-49, Figure 8-54, A6 board Schematic diagram:
Change the values of A6C4, C19 and C20 to 0.047µ.

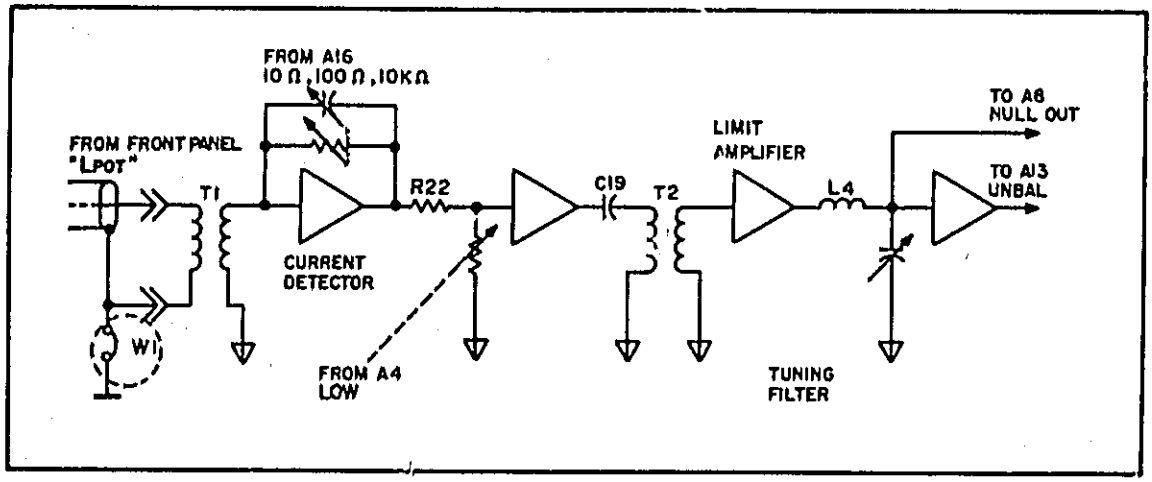
Page 8-51, Figure 8-58, A7 Board Schematic Diagram:
Change the values of A7C4, C19 and C20 to 0.047µ.

Page 8-61, Figure 8-78, A12 Board Schematic Diagram:
Change the value of A12C9* to 200p.
Change the value of A12R42* to 15.4K.
Change the value of A12R56* to 10K.

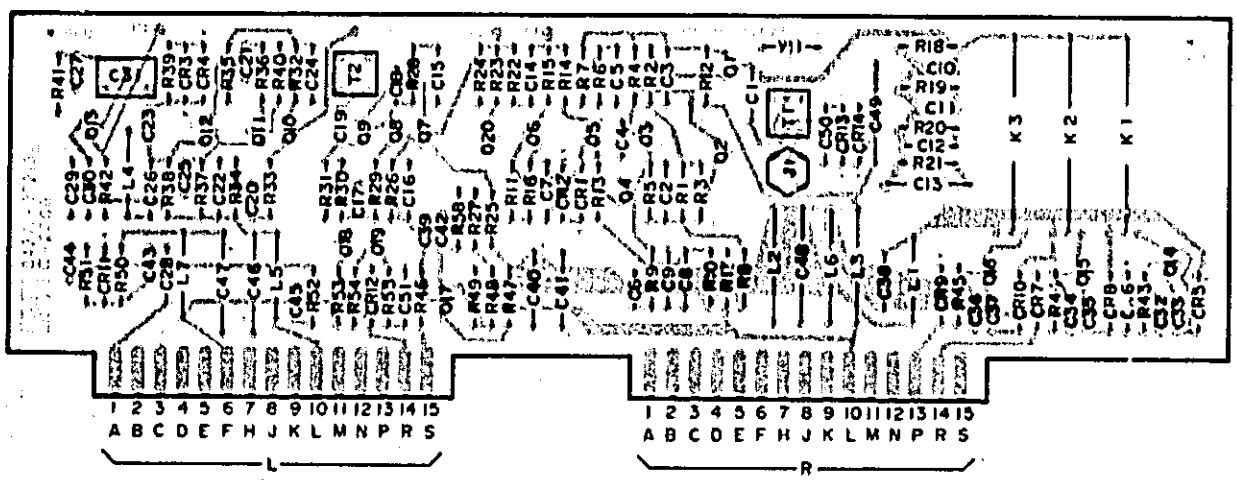
CHANGE 2

Pages 6-17 and 6-23, Table 6-3, Replaceable Parts:
Refer to the parts change list.

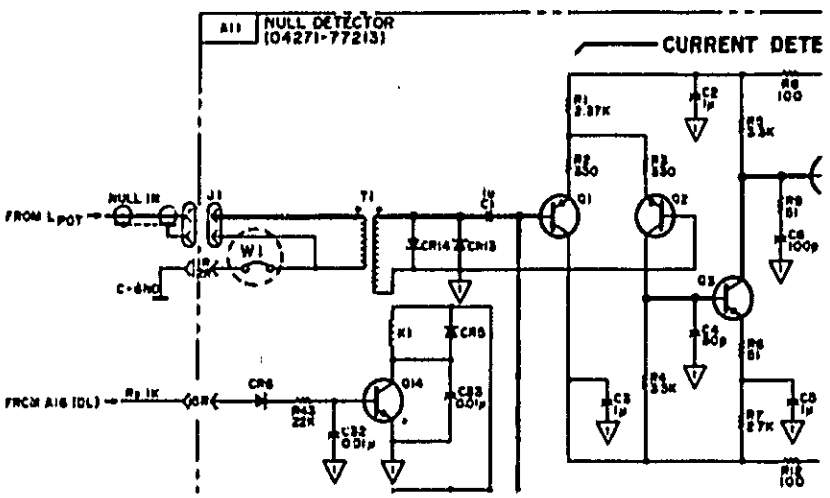
Page 8-58, Figure 8-72, Block Diagram of A11 Board:
Change the schematic as follows.



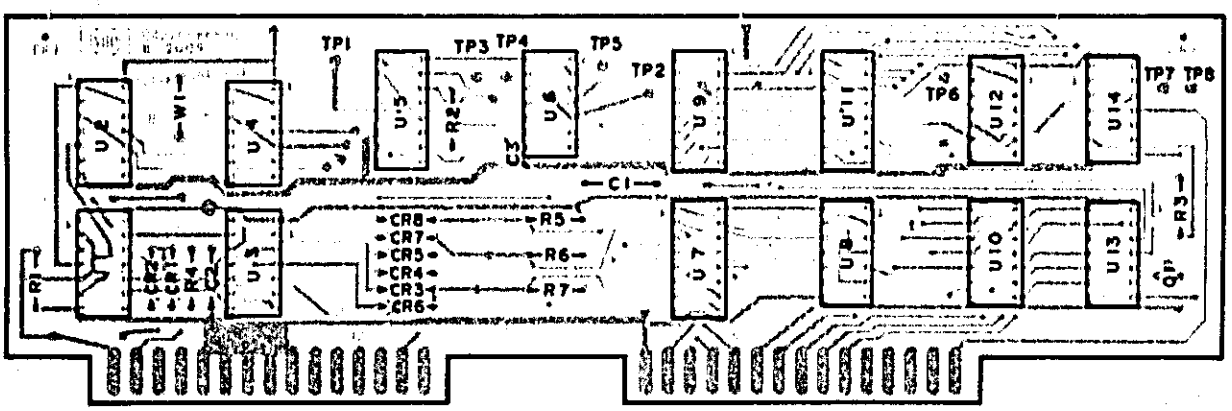
Pages 8-59, Figure 8-73, A11 Board Component Locations:
Change the diagram as follows.



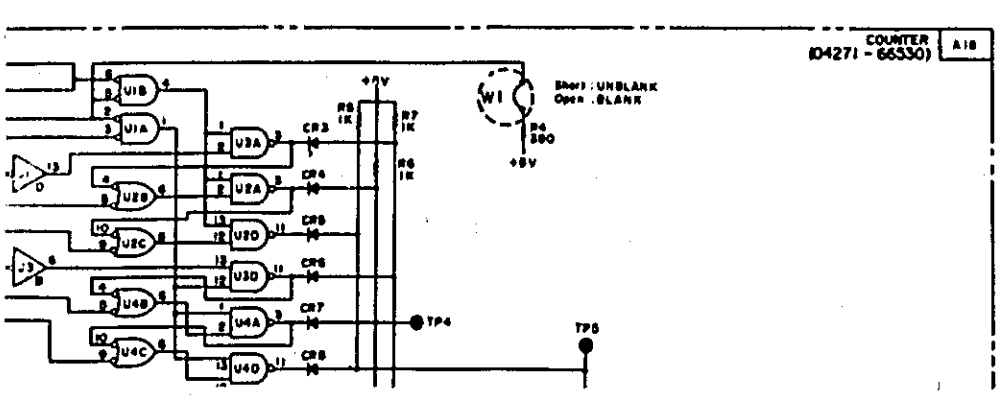
Page 8-59, Figure 8-74, A11 Board Schematic Diagram:
Designate the unmarked jumper W1 as shown below.



Page 8-73, Figure 8-101, A18 Board Component Locations:
Change the diagram as follows.



Page 8-73, Figure 8-102, A18 Board Schematic diagram:
Designate the unmarked jumper W1 as shown below.



CHANGE 3

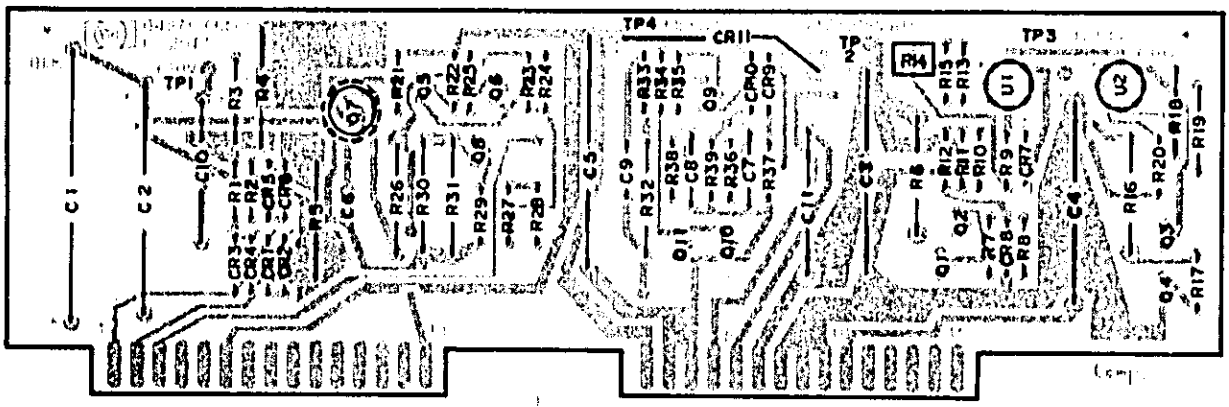
Pages 6-19 amd 6-20, Table 6-3, Replaceable Parts:
Refer to the parts change list.

Page 8-63, Figure 8-82, A13 Board Schematic Diagram:
Change the value of A13C4 to 33µ.
Change the value of A13C5 to 22µ.
Change the value of A13R20 to 30.1K.

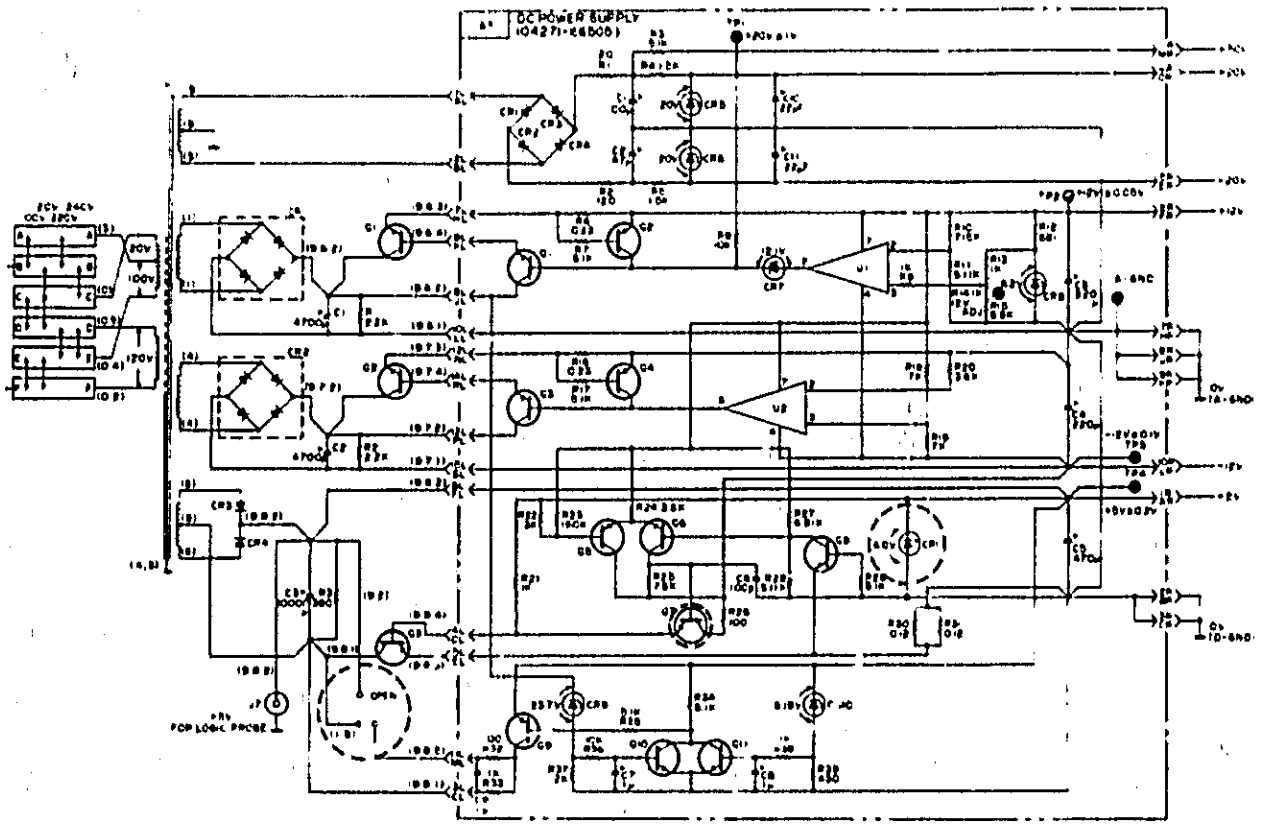
CHANGE 4

Pages 6-4 and 6-30, Table 6-3, Replaceable Parts:
Refer to the parts change list.

Page 8-43, Figure 8-42, A3 Board Component Locations:
Change the diagram as follows.



Page 8-43, Figure 8-42, A3 Board Schematic Diagram:
Change the schematic as follows.



Change the part numbers and descriptions of the replaceable parts in accordance with the table below:

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
ERRATA	6-11	C	A8R39	0683-5625	RESISTOR 5.6K 5% .25W FC TC=-400/+700
		C	A8R52	0683-2025	RESISTOR 2K 5% .25W FC TC=-400/+700
		C	A8R58	0683-2225	RESISTOR 2.2K 5% .25W FC TC=-400/+700
		C	A8R62	0683-5125	RESISTOR 5.1K 5% .25W FC TC=-400/+700
	6-13	C	A10C4	0160-0127	CAPACITOR-FXD 1µF ±20% 25VDC CER
	6-14	C	A10K1	0490-0875	RELAY 2C 12VDC-COIL 2A 30VDC
	6-27	A	A24R7	0683-5635	RESISTOR 56K 5% .25W FC TC=-400/+800
		A	A25R14	0683-5635	RESISTOR 56K 5% .25W FC TC=-400/+800
1	6-4	C	A3C6	0160-2204	CAPACITOR-FXD 100pF+5% 300VDC MICA
		C	A3C10	No change	CAPACITOR-FXD 22µF 63V
		C	A3C11	No change	CAPACITOR-FXD 22µF 63V
		C	A4C1	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4C5	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-5	C	A4C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4C8	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A4CR1	1902-1382	DIODE-ZNR 6.8V 5% PD=.4W
		C	A4Q1	5080-3835	No change
		C	A5C5	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C14	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C19	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C20	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A5C21	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-6	C	A5R35	0698-3154	No change
		C	A6C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C4	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A6C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C9	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C11	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C13	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	▶ A6C15	0160-6406	CAPACITOR-FXD .068µF
		C	A6C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C18	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER

Change	Page	Note	Reference Designation	HP Part Number	Description
1	6-6	C	A6C19	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A6C20	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A6C21	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-7	C	A6C22	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C26	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C27	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A6C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A6Q8	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
		▶ C	A6Q13	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
	6-8	C	A7C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C4	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A7C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C9	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C11	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C13	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A7C15	0160-6406	CAPACITOR-FXD .068µF
		C	A7C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C18	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C19	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A7C20	0160-5269	CAPACITOR-FXD 0.047µF +10% 50VDC CER
		C	A7C21	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C22	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C26	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C27	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A7C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-9	▶ C	A7Q8	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
		▶ C	A7Q13	1855-0570	TRANSISTOR-FET 2SK523-L1∿L2
	6-10	C	A8C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C8	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C27	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C29	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C30	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C40	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C41	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C43	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8C44	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A8Q1	5080-3830	No change
		C	A8Q2	5080-3830	No change
		C	A8Q3	5080-3830	No change

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
1	6-10	C	A8Q4	5080-3830	No change
		C	A8Q9	5080-3830	No change
		C	A8Q11	5080-3830	No change
	6-12	C	A9C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A9C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-13	C	A10C3	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A10C10	0160-4796	CAPACITOR-FXD 3.9pF ±0.25pF
		C	A10C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C13	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C15	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C17	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C23	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C24	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C25	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A10C31	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-14	C	A10Q5	5080-3830	No change
		C	A10Q10	5080-3830	No change
		C	A10Q12	5080-3835	No change
		C	A10Q14	5080-3835	No change
	6-15	C	A11C7	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C15	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C16	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C22	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C24	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-16	C	A11C26	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C28	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C29	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C30	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A11C51	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-17	C	A12C9*	0140-0198	CAPACITOR-FXD 200pF ±5% 300VDC MICA
	6-19	C	A12R42*	0698-3540	RESISTOR 15.4K 1% .125W F TC=0±100
		C	A12R56*	0757-0442	RESISTOR 10K 1% .125W F TC=0±100
		C	A13C10	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A13C11	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		C	A13C12	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-20	C	A14C6	0160-4834	CAPACITOR-FXD .047µF ±10% 50VDC CER
		▶ C	A14C9	0160-4574	CAPACITOR-FXD 1000pF
	6-23	C	A18C2	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
		▶ C	A18C3	0160-4574	CAPACITOR-FXD 1000pF

Change	Page	Note	Reference Desig-nation	HP Part Number	Description
	6-26	C C C	A21U4 A21U5 A21U6	1820-1411 1820-1411 1820-1411	IC LCH TTL LS D-TYPE 4-BIT IC LCH TTL LS D-TYPE 4-BIT IC LCH TTL LS D-TYPE 4-BIT
	6-28	C	A31C6	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER
	6-29	C C	A34J1 A34J2	1200-0607 1200-0607	No change No change
1	6-30	C	J5	1510-0310	No change
2	6-17	A	A11W1	8159-0005	RESISTOR-ZERO OHMS 22 AWG LEAD DIA
	6-23	A	A18W1	8159-0005	RESISTOR-ZERO OHMS 22 AWG LEAD DIA
3	6-19	C C	A13C4 A13C5	0180-0229 0180-0228	CAPACITOR-FXD 33µF CAPACITOR-FXD 22µF
	6-20	C C	A13R20 A13U5	0757-0453 1820-0371	RESISTOR 30.1K 1% .125W F TC=0±100 IC GATE TTL H NAND TPL 3-INP
4	6-4	A	A3CR11	1902-0552	DIODE-ZNR 6.0V
	6-30	D	CR5	1884-0005	DIODE: THYRISTOR (SCR) 50V

▶: New item C: Change D: Delete A: Add